4. ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

The potential environmental consequences of both the National Aeronautics and Space Administration's (NASA) Proposed Action (Preferred Alternative) to continue preparations for and to implement the Constellation Program, and the No Action Alternative, not continue preparations for nor implement the Constellation Program, are summarized in Chapter 2 and are presented in detail in this Chapter. In addition, this Chapter presents in Cumulative Impacts (see Section 4.3) the potential environmental consequences of two overlapping but individual NASA actions: implementing the Constellation Program and close-out of the Space Shuttle Program.

4.1 ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION (PREFERRED ALTERNATIVE)

Under the Proposed Action, NASA would continue preparations for and implement the Constellation Program. This Program would involve activities at many U.S. Government and commercial facilities. Although detailed aspects of the Constellation Program and the full scope of the activities that might occur at each facility are not fully known, the activities described in Section 2.1 present enough information to broadly estimate the nature of the potential environmental impacts that might occur if NASA implements the Proposed Action.

Figure 2-2 presents a high-level summary of the major Constellation Program activities that would be expected to occur at each of the primary U.S. Government facilities, as well as commercial facilities with the potential for significant environmental impacts. Given the long-term nature of the Constellation Program, and NASA's desire to utilize as much of the Space Shuttle Program infrastructure as practicable, it is expected that over time, many of the existing facilities currently used by the Space Shuttle Program and planned to be used for the Constellation Program would require maintenance, upgrading, renovation, and/or replacement.

For evaluation purposes, this Final Programmatic Environmental Impact Statement (PEIS) discusses the potential environmental impacts of the proposed Constellation Program activities at each NASA Center, and other U.S. Government or commercial facilities, and at more broadly defined locations (*e.g.*, the Atlantic, Indian, and Pacific Oceans) for which impact locations are undefined at this time. For each site, the potential environmental impacts are presented in a number of broad areas. For each area, only potential impacts deemed more than minimal in nature are described.

It is anticipated that the nature and locations of many activities associated with the Constellation Program would be similar to the ongoing activities conducted in support of the Space Shuttle Program. Thus, the known environmental impacts of the Space Shuttle Program have been used as the baseline for predicting potential impacts of implementing the Constellation Program. The impacts of the Space Shuttle Program have been well-characterized in NEPA documents prepared for the Space Shuttle Program, including site- or program-specific NEPA documents, in analyses documented by the Space Shuttle Program, and in Environmental Resources Documents for various NASA Centers.

4.1.1 Potential Environmental Impacts at U.S. Government Facilities

4.1.1.1 John F. Kennedy Space Center

Table 4-1 summarizes the major activities currently anticipated at the John F. Kennedy Space Center (KSC) in support of the individual projects within the Constellation Program. At KSC, most of the reasonably foreseeable activities would be similar to ongoing activities conducted in support of the Space Shuttle Program. As such, the environmental impacts of implementing the Constellation Program at this site would be expected to be similar to the environmental impacts of the ongoing Space Shuttle Program, which have been documented in various environmental documents, including the KSC Environmental Resources Document (KSC 2003).

Table 4-1. Description of Constellation Program Activities at KSC

Constellation Program Project	Project Responsibilities
Project Orion	Manage: • Ground processing, launch operations, and recovery support during design, development, test, and evaluation phases of Orion development • Final integration of Orion spacecraft • Ground support equipment development and support
Project Ares	Ground processing, launch operations, and recovery support for Ares I and Ares V
Ground Operations Project	Manage: • Design, development, testing and evaluation, and logistics activities for all ground processing, launch, and recovery systems • Ground processing, launch, and landing recovery operations planning and execution

Several of the facilities at KSC identified for potential use in the Constellation Program may require modification. In some cases, new facilities may be needed. Many of the modifications would be relatively simple such as internal upgrades to electrical wiring and moving interior walls. However, some of the modifications would be more extensive. Table 2-10 summarizes new facility construction and modifications being considered to support the Constellation Program where the modifications might impact historic facilities or have the potential for environmental impacts sufficient to require additional analysis under an environmental assessment (EA) or an EIS. See Section 4.1.1.1.8 for discussion of historic/cultural impacts associated with the construction activities.

In order to meet the proposed timeline of the Constellation Program, some actions needed to be accomplished before the NEPA process for this PEIS is completed. Included are the near-term modifications to the Launch Complex (LC)-39 Pad B launch tower, installation of a lightning protection system, and the construction of a new mobile launcher to accommodate the initial test launches of the Ares I. Therefore, NASA prepared and published the *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program, John F. Kennedy Space Center, Florida* (KSC 2007f) to address these modifications and the associated environmental impacts of construction and operation. NASA signed a Finding of No Significant Impact (FONSI) on May 2, 2007 allowing for the proposed action to proceed. The potential environmental impacts of construction and operation addressed in that EA are summarized as appropriate in the following subsections.

Similar modifications to those underway for LC-39 Pad B (KSC 2007f) would be needed at LC-39 Pad A to accommodate Ares V launches. Therefore, the potential environmental impacts of modifying and operating LC-39 Pad A would be similar to those for LC-39 Pad B. In addition, the mitigation measures adopted for LC-39 Pad B would be adopted for LC-39 Pad A. It is NASA's intention that both Ares launch vehicles would be able to be launched from these two launch pads.

As the planning for the Constellation Program proceeds and matures, construction of new facilities or modifications to existing facilities that are currently unanticipated may be deemed necessary. These activities would be subject to separate NEPA review and documentation, as appropriate.

The following sub-sections discuss the potential environmental impacts of Constellation Program activities at KSC.

4.1.1.1.1 Land Resources

Activities described under the Proposed Action would not impact or conflict with land use plans at KSC. There are several tracts of largely undisturbed natural areas within KSC, including the Merritt Island National Wildlife Refuge (MINWR) and the Cape Canaveral National Seashore. There are also various wildlife management areas and wetlands located within both KSC and Merritt Island. None of these areas would experience impacts exceeding those currently experienced under the Space Shuttle Program.

KSC is within the Coastal Zone as defined by Florida Statute (15 CFR 930.30-44). As such, a Coastal Zone Consistency Determination for the Proposed Action is required. NASA has performed such a Determination and has determined that the Proposed Action can be implemented within existing environmental regulations and is consistent with the Florida Coastal Zone Management Plan.

4.1.1.1.2 Air Resources

This discussion has been divided into sections that address normal launches and launch accidents. See Section 4.1.1.1.12 for a discussion of air quality impacts associated with launch accidents.

The principal sources of air emissions at KSC during the Constellation Program would be vehicular traffic from workers and visitors, especially on launch days, and the exhaust clouds from test launches and mission launches. Any long-term incremental changes in vehicular emissions due to the Proposed Action would be proportional to the size of the workforce and are not known at this time. The number of launches per year would be comparable to the historic Space Shuttle launch schedule. In addition, vehicular emissions created by visitors on launch days would be similar to those created during Space Shuttle launches. Increases in fugitive dust during construction are not expected to be a major source of air emissions and have been previously addressed (KSC 2007f).

Launches involving solid rocket boosters (SRBs) produce several pollutants of concern from igniting the solid propellants: hydrogen chloride (HCl), aluminum oxide (Al_2O_3) particulate matter, and nitrogen oxides (NO_x). HCl and Al_2O_3 are products of the combustion of the solid propellants. NO_x is produced by the combustion of atmospheric nitrogen under high-temperature conditions and is a contributing pollutant in the formation of ground-level ozone (O_3).

Space Shuttle launches at KSC and launches from Cape Canaveral Air Force Station (CCAFS) serve as a basis for understanding the expected emissions from normal launches of the Ares launch vehicles and their effects on the surrounding environment. Factors determining the ground-level impacts from launches would be receptor location and meteorology, more so than quantities of emissions from the launch vehicle. Therefore, the differences in air emissions between Ares and Space Shuttle launches (due to differences in solid propellant quantities or aspects of the launch pad sound suppression systems) would have less influence on the relative impacts from each launch vehicle than would variations in meteorological conditions (KSC 2007a).

The impacts associated with Space Shuttle launches have been well-characterized (KSC 1985). These impacts are principally associated with HCl and Al_2O_3 emissions from the Space Shuttle SRBs at liftoff. The interaction of these emissions with water from the Space Shuttle's sound suppression system creates a wet acidic deposition that produces the majority of the local environmental impacts near the launch complex (AIAA 1993). Lengthy environmental monitoring and assessment programs associated with Space Shuttle launches have led to a better understanding of the scope and magnitude of launch environmental effects. The Ares I First Stage and the Ares V SRBs would produce the same pollutants as the Space Shuttle at launch.

Launch impacts may be described in terms of the following categories: 1) exhaust emissions directly at the launch pad that remain and are deposited in that area, 2) near-field impacts from the exhaust cloud (generally within 500 meters [m] [1,640 feet [ft]) but sometimes up to 1,000 m [3,280 ft] from the pad), 3) impacts from far-field deposition of the buoyant portion of the exhaust cloud (more than a few kilometers from the launch pad), and 4) impacts on the stratosphere as the launch vehicle passes through it. The fourth category is described in detail in Section 4.1.6.1.

Much of the Space Shuttle emissions that are confined to the launch pad become entrained in the 3 million liters (l) (800,000 gallon [gal]) of sound suppression system water sprayed into a flame trench beneath the Space Shuttle at liftoff. After a launch, HCl may revolatilize as water evaporates on the launch pad.

The near-field impacts from an exhaust cloud depend primarily on the amount of sound suppression system water (its evaporation lowers the temperature and the altitude of the exhaust cloud) and on the time that the launch vehicle remains near the launch pad during ascent. The observations of near-field impacts from launches have been well-documented based on many years of Space Shuttle launches. They include destruction of sensitive plant species followed by regrowth, a rapid, two to three day drop in pH (a measure of acidity/alkalinity) in nearby waters down to 1 m (3.3 ft), which results in fish kills in the shallow surface waters of the lagoons north of LC-39 Pad A or the impoundments north of LC-39 Pad B, both of which are in line with the pad flame trenches. This is followed by a return to normal pH levels, and possibly deaths of burrowing animals in the path of the exhaust cloud. The near-field impacts from exhaust clouds have been observed at distances up to a few hundred meters from the launch pad, well within KSC/CCAFS, and do not reach human populations offsite (KSC 1985, AIAA 1993).

HCl deposition on leaves has been detected up to 22 kilometers (km) (13.6 miles [mi]) away following a Space Shuttle launch. Although the HCl deposition persists on leaf surfaces for considerable periods, no mortality of these plants and no changes in plant community composition or structure have been observed in the far-field related to launch effects (KSC 1985, AIAA 1993).

The Ares I would use the same type of SRB propulsion as does the Space Shuttle, as would the Ares V in its current planning configuration. The Ares I First Stage would use less solid propellant than the Space Shuttle at launch and the Ares V would use more solid propellant than the Space Shuttle. The difference in the total mass of solid propellant would primarily affect the exhaust cloud generated as the vehicle ascends to orbit and would not be a significant concern at the launch site. The potential exhaust cloud effects for an Ares launch would remain similar to those documented for Space Shuttle launches (KSC 2007a). Specifically, the same type effects from acidic deposition associated with Space Shuttle launches would be expected from the Ares vehicles. While the real extent and magnitude of impacts would depend in large part on the final launch pad configuration and volume of sound suppression system water entrained in the exhaust cloud, the impacts from an Ares I launch would be less than for an Ares V or the Space Shuttle.

Differences in local environmental effects between Space Shuttle and Ares launches could result if the amount of sound suppression system water for liftoff differed significantly. It is possible that final designs of the Ares vehicles and launch pads may employ significantly less sound suppression water (KSC 2007a). Reductions in the amount of water utilized would lessen the spatial extent and severity of impacts from wet acidic deposition. The exact amount of sound suppression system water utilized for Ares launches is still to be determined, but the amount currently used for the Space Shuttle could be used as a representative case to assess the scope and magnitude of local environmental impacts from Ares launches (KSC 2007a).

The current Ares V concept would use five liquid-fueled (liquid hydrogen/oxygen [LH/LOX]) RS-68B main engines, in addition to the two SRBs, at launch; thus, the Ares V would produce more heat in the exhaust than the Space Shuttle's main engines. This hotter exhaust would be more buoyant and would result in more emissions being carried aloft in the Ares V exhaust cloud, thus decreasing the near-field effects. An Ares V launch, by using approximately 25 percent more solid propellant in each SRB than the Space Shuttle, would release more emissions overall than the Space Shuttle.

The far-field impacts (more than a few kilometers from the launch pad) would be expected to be similar to the Space Shuttle (*i.e.*, negligible). When launches are planned, the KSC/CCAFS Range Safety Office, in general referred to as Launch Range Safety, uses computer modeling and launch safety criteria to ensure that significant far-field effects would not be expected. When the Ares I and Ares V launch specifications are determined, Launch Range Safety would provide these inputs to the air diffusion models used to determine if it is safe to launch under the current and projected meteorological conditions.

4.1.1.1.3 Water Resources

Constellation Program activities at KSC would not be expected to have substantial adverse impacts on surface water or groundwater resources at KSC. The principal source of potential impacts on water resources would be Ares launches.

Direct impacts to surface waters from heat, vibration, and exhaust products are expected within a few hundred meters of the launch area. Figure 4-1 illustrates the major surface water bodies in and surrounding KSC. LC-39 Pads A and B are near the Mosquito Lagoon, Banana Creek, Banana River, and Indian River, and an Ares exhaust cloud could impact any of these water bodies, depending on the wind direction (KSC 2003). Water quality near the launch area could be affected as a result of contamination of surface waters by the exhaust cloud; however, long-term adverse effects are not anticipated. Thus, if launch activities do not adversely affect the water quality in the vicinity of the launch site, the Atlantic Ocean and coastal region would not be impacted.

Space Shuttle launches from LC-39 typically result in temporary impacts to the waters of adjacent impoundments. These impacts consist of a sharp but temporary depression of pH due to removal of HCl from the exhaust cloud formed by the combustion products of the solid fuel in the SRBs. Launch of the Ares vehicles would have similar effects.

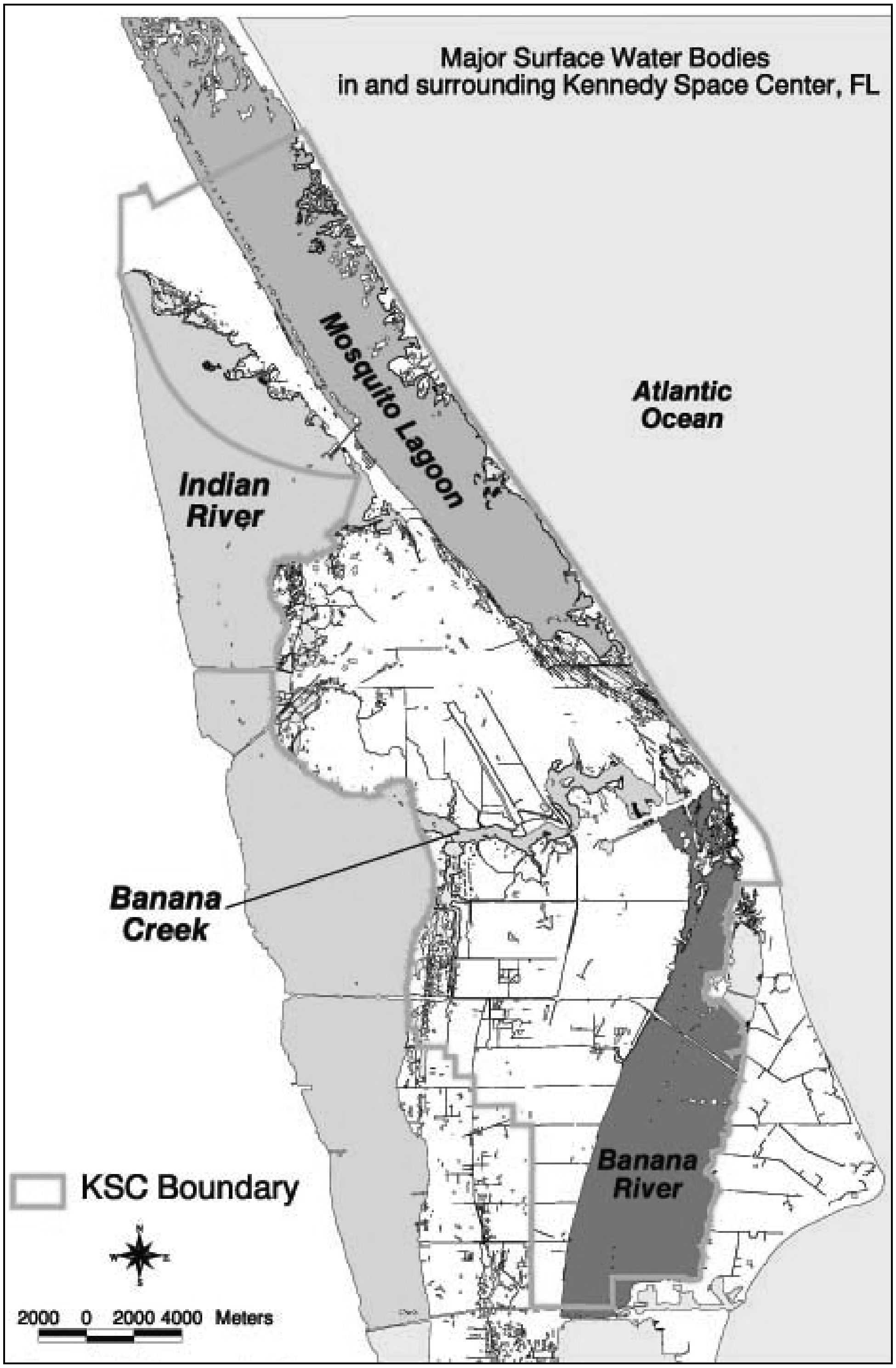
Much of the sound suppression system water used for a Space Shuttle launch is vaporized and is contained in the exhaust cloud. Post-launch, approximately 1.1 million l (300,000 gal) of the sound suppression system water is collected in tanks, treated to a neutral pH, and spread onto the unpaved ground near the launch pad. Although the quantity of sound suppression system water that would be used for Ares launches is not currently defined, it is expected that it would be treated similarly and would produce no substantial environmental impacts. The EA prepared in support of modifications to LC-39 Pad B has reported that no substantial impacts to surface water or groundwater would be anticipated from these actions (KSC 2007f).

Similar additions and modifications to LC-39 Pad A would be necessary to support Constellation Program activities. It is anticipated that surface water and groundwater resources and quality would not be adversely impacted at LC-39 Pad A as a result of planned construction activities.

The Constellation Program would not result in potable water and sanitary sewer demand beyond the capacity of the current KSC infrastructure.

4.1.1.1.4 Noise

Implementation of the Proposed Action at KSC would be expected to result in the continuation of many of the types of noise presently occurring at the site. Noise generated at KSC has been extensively characterized (KSC 2003). Table 4-2 presents typical noise levels at the KSC Industrial Area from ongoing and historical operations, as well as estimated noise levels from sonic booms over the open ocean under the Space Shuttle flight path.



Source: KSC 2003

Figure 4-1. Location of the Major KSC Water Bodies

Table 4-2. Measured Noise Levels at KSC

Source	dBA Range		Remarks
	Low	High	
Atmospheric Entry Sonic Boom [a]			
Space Shuttle Orbiter	—	—	101 N/m^2 maximum. (2.1 psf)
Space Shuttle SRB Casing	—	—	96 to 144 N/m^2 (2 to 3 psf)
Space Shuttle External Tank	—	—	96 to 192 N/m^2 (2 to 4 psf)
Launch Noise			
Titan IIIC	[b]	94	21 Oct 1965 (9,388 m from pad)
Saturn I	[b]	89	Average of three measurements (9,034 m from pad)
Saturn V	[b]	91	15 Apr 1969 (9,384 m from pad)
Atlas	[b]	96	Comstar launch (4,816 m from pad)
Space Shuttle	[b]	90[a]	9,384 m from pad
Aircraft			
F4 Jet	[b]	107	18 km from Ground Zero
F4 Jet	[b]	158	Calculated at Ground Zero
NASA Gulfstream	87	109	Takeoff
NASA Gulfstream	87	100	Landing
Industrial Activities			
Multiple Facilities	45 to 106	57 to 199	Industrial Equipment Use
Undisturbed Areas			
Seashore	50	69	Medium Waves (Nice Day)
Riverbank	48	48	Light Gusts (No Traffic)
150 m Tower	50	64	Light Gusts of Wind

Sources: KSC 2003, NASA 1978

[a] Estimated noise levels over the open ocean under the vehicle flight path.
[b] Not measured or not applicable.

A number of aircraft are utilized at KSC for payload delivery, personnel transportation, and astronaut training. With adoption of the Proposed Action, intermittent aircraft noise would be expected to continue. Industrial activities associated with the Constellation Program would be similar in type and extent to those performed for the Space Shuttle Program, thus noise associated with industrial activities would be expected to continue at the present levels if the Proposed Action were adopted. The Proposed Action would include construction and modifications to existing facilities at KSC, which would result in localized noise around construction sites and from vehicular traffic supporting the construction activities. The workforce would be protected from undue noise impacts by the Occupational Safety and Health Administration (OSHA) safety practices in place at KSC.

Launch Noise

Launch vehicles generate very loud instantaneous noise that can usually be heard for several miles from KSC/CCAFS launch sites. In addition, a sonic boom is generated with some types of launches. Sonic booms associated with Ares launches from KSC are discussed in the next section. Table 4-2 provides measured peak sound levels for a number of vehicles launched from KSC/CCAFS over the years and compares those values with other KSC noise levels.

Both experimental observations and modeling indicate that the overall noise levels associated with a launch vehicle are approximately correlated with total engine thrust. The attributes of noise generated (*e.g.*, tone and frequency) are dependent on many engine parameters, including mechanical power in the exhaust, nozzle diameters, exhaust flows, and other factors. The magnitude of the acoustic noise and vibration generated would depend on many factors, including configuration of the launch pad and sound suppression features incorporated into the launch pad design. The sound levels heard and felt some distance from the launch vehicle would depend not only on the magnitude of the noise source, but also natural factors including attenuation of the sound due to absorption by plants, reflection by structures, refraction of the sound due to temperature inversions, wind speeds, and other meteorological factors.

Table 4-3 compares the expected thrust (and thereby relative noise levels) at launch of the proposed Ares I and Ares V (in its current planning configuration) with other launch vehicles. The total thrust of the Ares V at launch would exceed that of the Saturn V and Space Shuttle by as much as 40 and 50 percent, respectively. Launch of the Ares V would be expected to generate noise, including vibration and ground waves, in excess of that experienced with the Space Shuttle and likely of the magnitude of or exceeding that of the Saturn V launches. The exact magnitude of the acoustic noise and vibration generated by the Ares launch vehicles would depend on many factors as noted previously, including engineering considerations such as the sound suppression techniques incorporated into the launch pad design.

Table 4-3. Sea Level Thrust of Various Launch Vehicles

Launch Vehicle	Sea Level Thrust at Launch
Ares V*	45×10^6 N (10×10^6 lbf)
Saturn V	33×10^6 N (7.5×10^6 lbf)
Space Shuttle	31×10^6 N (6.9×10^6 lbf)
Titan IV	15×10^6 N (3.4×10^6 lbf)
Ares I	13×10^6 N (3×10^6 lbf)
Atlas V 551	9.8×10^6 N (2.2×10^6 lbf)
Delta 4 Heavy	8.9×10^6 N (2×10^6 lbf)

lbf = pounds force, N = Newton

* Current planning configuration with five RS-68B engines

Launch noise modeling was performed for both Ares I and Ares V (KSC 2007c) using techniques similar to those performed for the Space Shuttle and other current launch vehicles. Noise modeling was performed for both vehicles on the pad (where the noise pattern is significantly affected by the launch pad structures) and at an altitude of 91 m (300 ft) where each launch vehicle would be clear of the launch tower and the transmission of sound would be unabated and unobstructed.

The exposure to noise generated by Ares I and Ares V launches would last only for a very short duration (approximately 20 to 30 seconds). Audible frequencies (20 to 1,000 Hertz) generated by launch vehicles typically decrease as the launch vehicle travels away from the observer (*i.e.*, as the vehicle leaves the pad). Inaudible frequencies (between 1 to 20 Hertz) travel far, but do not affect human hearing.

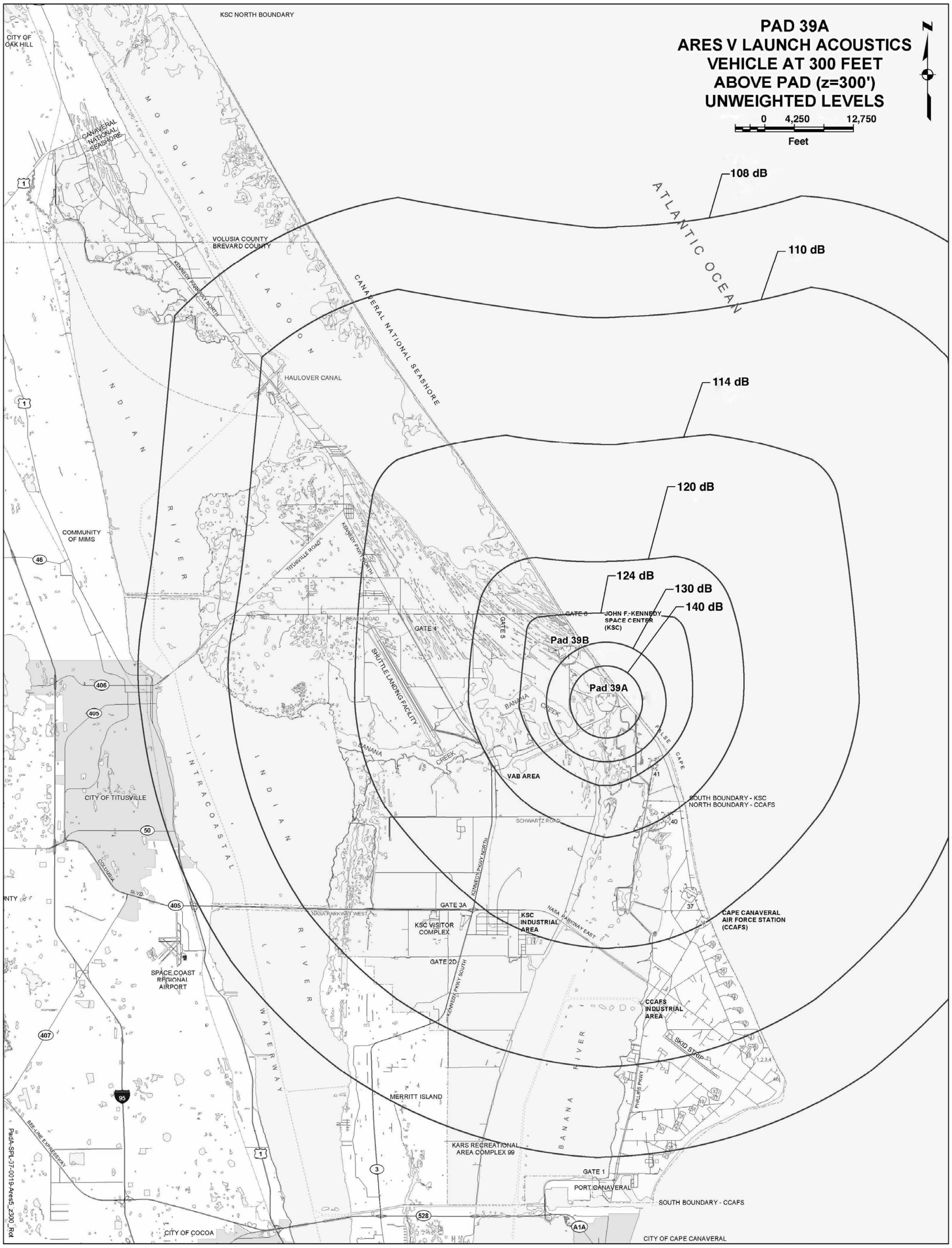
For both the Ares I and Ares V, overall sound pressure levels (OASPLs) were estimated. Both un-weighted (dB) and A-weighted (dBA) noise contours were overlaid on a KSC regional map. The dBA scale is commonly used in environmental noise measurement because it emulates how the human ear responds to noise across the entire sound frequency range. The dBA reflect how loud humans perceive the noise while dB reflect the actual sound pressures and the potential for psychological or structural damage.

Figure 4-2 presents the OASPLs in dB for the Ares V at 91 m (300 ft). Noise modeling for the Ares V was performed using a bounding launch configuration with a total thrust of about 54.7 million N (12.3 million lb) rather than the current planning configuration thrust of about 44 million N (10 million lb). A bounding launch configuration was used to consider potential variations in future engine designs and configurations. Short duration (approximately 20 to 30 seconds) sound pressure levels of about 106 to 109 dB are indicated for the city of Titusville. The KSC Visitor Center and KSC Industrial Area would experience 113 to 115 dB sound pressure levels. For the Ares I vehicle, short duration sound pressure levels were predicted to be approximately 8 to 9 dB lower at those locations.

Figure 4-3 presents dBA noise contours for the Ares V at 91 m (300 ft) using the bounding launch configuration. Short duration noise levels for the city of Titusville during an Ares V launch would be expected to be in the 78 to 82 dBA range. The predicted short duration noise levels at the KSC Visitor Center and KSC Industrial Area would be 88 to 92 dBA.

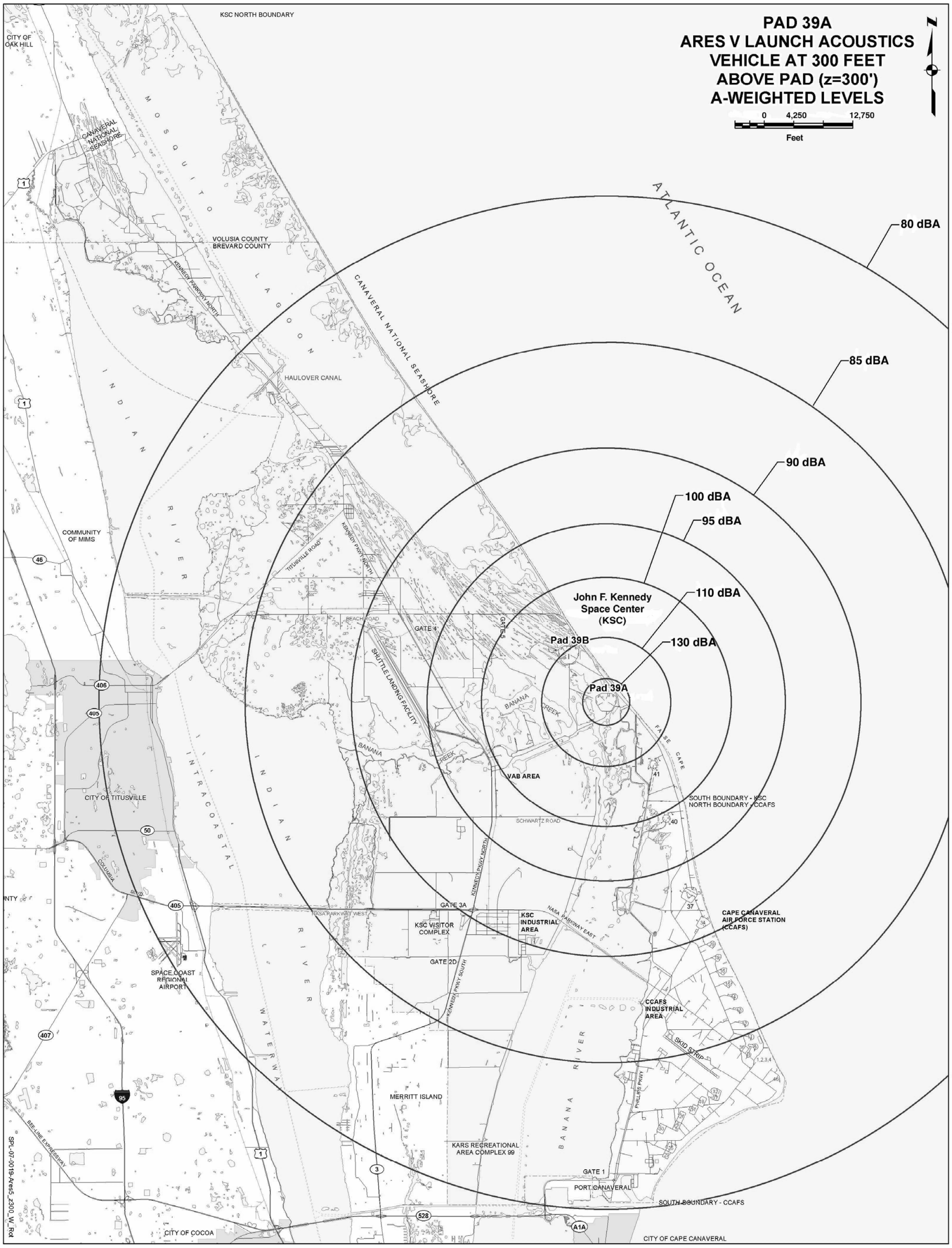
At 4.8 km (3 mi) away from the launch pad (the approximate distance to the Vehicle Assembly Building [VAB]), Ares V noise levels would be in the range of 99 to 102 dBA. Most KSC employees would be stationed beyond this distance. Noise levels of about 98 dBA would occur at the Saturn V viewing site with this bounding the Ares V launch vehicle configuration. These values are comparable to, but likely to be a few dBA (1 to 2) higher than, those of the Space Shuttle and the Saturn V used to launch the Apollo missions in the 1970s. For the Ares I, noise levels were predicted to be approximately 5 to 9 dBA lower at those locations.

Ares V offsite noise levels in Titusville of 78 to 82 dBA for 30 seconds would be much lower and experienced for significantly shorter duration than the 85 dBA 8-hour exposure threshold at which OSHA requires a hearing conservation program (29 CFR 1910.95). OSHA also requires that hearing protection or engineering controls be applied if workers are exposed to sound levels greater than 115 dBA for more than a quarter of an hour (29 CFR 1926.52).



Source: KSC 2007c

Figure 4-2. Calculated Un-weighted Maximum Sound Pressure Level Contours for an Ares V Launch



Source: KSC 2007c

Figure 4-3. Calculated A-weighted Maximum Sound Pressure Level Contours for an Ares V Launch

Sonic Booms Associated with Launch

Launch of an Ares I or Ares V would result in sonic booms similar to those that occur with each Space Shuttle launch from KSC or with expendable launch vehicle launches from CCAFS. Sonic booms are generated by the ascending Space Shuttle, with the atmospheric entry of jettisoned SRB casings, and with atmospheric entry of the jettisoned External Tank.

Sonic booms with the launch of an Ares I or Ares V would occur in similar locations to where Space Shuttle sonic booms occur. The focal zone of peak noise would be along the ground track of the flight path of the vehicle. The direction of the flight path, or launch azimuth, would vary with the destination of the vehicle (*e.g.*, International Space Station, Moon, or Mars). The largest sonic boom associated with the ascending Space Shuttle first reaches ground level about 60 km (37 mi) downrange with pressures as high as 290 Newtons per square meter (N/m^2) (6.0 pounds per square foot [psf]). The intensity diminishes downrange to 48 N/m^2 (1.0 psf) at approximately 85 km (53 mi) (NASA 1978).

In principle, sonic boom overpressures increase with the size of the vehicle and its exhaust plume, but the shape of the vehicle also would play an important role. Therefore, the Ares I overpressures should be less than the Space Shuttle, and the Ares V overpressures may be similar to the Space Shuttle.

For Space Shuttle launches, after SRB separation the Space Shuttle and External Tank continue to climb while the SRBs reenter the atmosphere. During descent and prior to parachute deployment, the spent SRBs generate sonic booms, which would strike the Atlantic Ocean surface over an area from 280 to 370 km (174 to 230 mi) downrange from the launch site. Maximum overpressures of 96 to 144 N/m^2 (2 to 3 psf) could occur in this area, which coincides with the SRB impact area (NASA 1978). For both the Ares I First Stage and Ares V SRBs, a similar effect would be expected.

The targeted entry of the Ares V LOX/LH Core Stage and the Ares I Upper Stage also would produce sonic booms, much like that which occurs with entry of the External Tank from the Space Shuttle, over the Indian or the Pacific Ocean. Atmospheric entry of the Space Shuttle External Tank produces a sonic boom with maximum overpressures in the range of 96 to 192 N/m^2 (2 to 4 psf) (NASA 1978). The exact location of the sonic boom footprints from Ares launches would depend on the mission destinations (*e.g.*, International Space Station, Moon, or Mars) and the targeted disposal area (roughly 28 to 30° South latitude, 84 to 90° East longitude).

Impacts of Launch Noise on People

The noise from an Ares I launch would be expected to be somewhat less than a Space Shuttle launch, while the noise from the Ares V launch would likely be greater than from the Space Shuttle. The extent to which these differences would be perceivable to either onsite spectators or the offsite public is not known. The variability in the transmission of the noise from the launch area and the ascending launch vehicle due to atmospheric factors and meteorology is likely to be at least as important as the actual variation in noise generated by the vehicle. This is illustrated in Table 4-2 with a smaller launch vehicle (the Titan IIIc) having produced higher sound levels than the Space Shuttle at a measuring point 9 km (5.6 mi) away.

The effects of extended noise exposure on humans are outlined in Table 4-4. The exposure to noise generated by Ares I and Ares V launches would last only for a very short duration (approximately 20 to 30 seconds) and therefore the impacts would not approach those in Table 4-4. NASA ensures that workers and visitors are protected from launch noise levels that exceed regulated limits by controlling proximity to the launch pad and employing structural protection measures to shield personnel and visitors. All public exposure levels have been below those requiring protective devices for such short exposure; consequently, Space Shuttle launch acoustic impacts have been well within acceptable limits. It would be expected that these policies and procedures would continue with the launch of the Ares I and Ares V.

Table 4-4. Effects of Extended Noise Exposure on Humans

dBA Level	Potential Effect	dBA Level	Potential Effect
20	No sound perceived	85	Very annoying
25	Hearing threshold	90	Affect mental and motor behavior
30	—	95	Severe hearing damage
35	Slight sleep interference	100	Awaken everyone
40	—	105	—
45	—	110	—
50	Moderate sleep interference	115	Maximum vocal effort
55	Annoyance (mild)	120	—
60	Normal speech level	125	Pain threshold
65	Communication interference	130	Limit amplified speech
70	Smooth muscles/glands react	135	Very painful
75	Changed motor coordination	140	Potential hearing loss high
80	Moderate hearing damage	—	—

Source: KSC 2003

Impacts of Launch Noise on Structures

Noise from Space Shuttle launches (and from Saturn V launches in the 1960s and 1970s) has occasionally resulted in minor damage, such as broken windows and cracked plaster within buildings both offsite and at KSC/CCAFS. The principal risk to structures, however, is to close-in structures at KSC/CCAFS that might be subjected to larger acoustic energies. The risks are highest when the meteorological conditions result in acoustic focusing, which could produce sound levels 10 to 20 dB higher than would normally be experienced.

The potential impact of Ares I launch noise on structures would be expected to be minimal, since these noise levels should be lower than those experienced with Space Shuttle launches. The potential noise and vibration levels associated with Ares V launches would likely be comparable to past Space Shuttle and Saturn V launches; therefore, the potential for minor localized damage to windows (onsite and offsite) and structures exists. NASA has procedures in place to evaluate such damage and provide for compensation, if warranted. As the noise levels generated by the

Ares I and Ares V would be similar to past launches, they should not adversely impact surrounding communities.

<u>Impacts of Routine Operations Noise and Launch Noise on Wildlife</u>

Historically, 24-hour average ambient noise levels away from the industrial areas at KSC have been appreciably lower than the U.S. Environmental Protection Agency (EPA) recommended upper level of 65 dBA (KSC 2003). The areas of KSC/MINWR that are away from operational areas are exposed to relatively low ambient noise levels in the range of 35 to 40 dBA (KSC 2003). This indicates that the noise from routine, non-launch related activities at KSC has minimal affect on wildlife in these natural areas.

Studies have been conducted on the noise impacts from launch operations on wood storks, a federally endangered species, and are reported in the KSC Environmental Resources Document (KSC 2003). This report indicated a startle response occurred during Space Shuttle launches, but within 10 minutes the colony appeared to be functioning normally and no young were observed to be injured or killed from startle effects. Site visits made before and after the launches did not indicate any obvious adverse effects.

A noise survey performed on March 14, 1990, assessed the noise levels in the habitat of Florida scrub jays and beach mice during a Titan 34D launch from LC-40 at CCAFS. No conclusions were drawn from the field data; however, ongoing observations of the scrub jay do not indicate any adverse impact. Studies of reproductive success and survival of Florida scrub jays have been conducted surrounding the CCAFS former Titan launch pads, LC-40 and LC-41. No acute or obvious direct impacts have been found resulting from several launches where noise levels approached 140 dB (KSC 2003).

Studies were conducted on wading bird colonies subjected to military overflights (at 150 m [500 ft] of altitude) with noise levels up to 100 dBA. No productivity limiting responses were observed. Nesting birds are apparently more startled by human presence in the vicinity of the nest than by noise impacts (KSC 2003).

Bald eagles utilizing a nest adjacent to the Kennedy Parkway at KSC have received episodic sound exposures of 102 dBA during Space Shuttle launches. Observation showed that the startle response to such noise levels was short-term and caused no significant impact (KSC 2003).

4.1.1.1.5 Geology and Soils

No substantial environmental impacts to geology and soils have been identified from LC-39 Pad B construction activities described in the *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program, John F. Kennedy Space Center, Florida* (KSC 2007f). Similar modifications would be undertaken at LC-39 Pad A, and no substantial impacts to geology and soils would be anticipated. In addition to those facilities addressed in the EA, minor modifications are proposed for several processing facilities. These modifications are not believed to have any associated impacts, but would be subject to separate NEPA review and documentation, as appropriate.

Deposition of pollutants, principally HCl and Al_2O_3, from the exhaust cloud from the Ares I First Stage and the Ares V SRBs, would be similar to that currently experienced under the Space Shuttle Program. No long-term effects on geology or soils have been observed from the Space Shuttle launches (KSC 2003).

See Section 4.1.1.1.12 for a discussion of launch accidents and their potential impacts on geology and soils.

4.1.1.1.6 Biological Resources

The principal Constellation Program activity that would impact biological resources at KSC would be Ares launches. Space Shuttle launches typically result in a temporary startle response from nearby birds and other wildlife. Bald eagles, wood storks, and Florida scrub jays near the launch complex do not appear to have sustained any long-term adverse impacts from the periodic Space Shuttle launches. Temporary depression of pH in the lagoons and impoundments near LC-39 due to HCl removal from the exhaust cloud often results in a fish kill, of up to several hundred individual fish. These periodic events do not appear to have had a long-term adverse impact on fish populations in these shallow waters. It is anticipated that Ares launches from LC-39 would result in similar impacts.

Construction of, modifications to, and operation of LC-39 Pad B necessary to accommodate Ares launches are addressed in The *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program, John F. Kennedy Space Center, Florida* (KSC 2007f). These modification/construction activities would not adversely impact habitats or vegetation at KSC. No currently undeveloped land would be taken, and none would be affected by normal operations (KSC 2007f). Nighttime lighting would be required for the construction and operation of the mobile launch platform and during modifications to and operation of LC-39 Pad B. The LC-39 Pad B lightning protection system will consist of three free-standing towers approximately 184 m (605 ft) tall with a network of nine catenary grounding cables extending between the towers and to the ground. The towers will be 24 m (80 ft) apart, forming an equilateral triangle around the launch pad surface. These characteristics raise the potential for daytime and nighttime bird strikes and nighttime bat strikes on the tall towers and grounding cables, and the potential for the tower lighting to adversely impact sea turtle hatchlings and nesting behavior at night during the nesting season. Several structural and operational mitigation strategies to reduce these potential impacts have been identified (KSC 2007f), including following KSC Exterior Lighting Guidelines to help reduce the potential impact on sea turtles. KSC also would continue to monitor potential sea turtle disorientation in accordance with its 2006 agreement with the USFWS. NASA also would implement a monitoring protocol for bird strikes based on USFWS Division of Migratory Bird Management recommendations. NASA has consulted with the USFWS under Section 7 of the Endangered Species Act regarding the potential impacts from the proposed Constellation Program (KSC 2007d). These mitigation measures are summarized in Chapter 5 of this Final PEIS.

At such time as similar additions and modifications to LC-39 Pad A become necessary to support Constellation Program activities, it is anticipated that construction activities would not adversely impact habitats or vegetation, and that similar mitigation and monitoring measures would be taken with respect to potential bird and bat strikes and sea turtle disorientation as performed at LC-39 Pad B.

Given that Constellation Program activities would take place in previously disturbed areas and existing facilities, it is unlikely that there would be any adverse impacts to floodplains or wetlands at KSC.

Although fish kills in lagoons and impoundments near the launch site can be expected following launches, no reports have been found documenting adverse effects on the Atlantic coastal region, including threatened and endangered species, and no substantial adverse effects are expected outside the near-launch area (NASA 1996). Nevertheless, the net effect of ocean currents in this region is for material suspended in the water column to be confined near the coast, with heavier material deposited near shore (NASA 1995b); consequently, if launch material is transported to the Atlantic Ocean via surface water, it would not be transported out of the region.

NASA has consulted with the National Marine Fisheries Service (NMFS) on essential fish habitat regarding launches of Ares vehicles from KSC (KSC 2007e). NASA has indicated to NMFS that over more than 25 years of Space Shuttle operations, there have been no documented long-term impacts to marine life or marine habitats. Similarly, the proposed Constellation Program launches are not expected to produce any measurable impacts to marine species or habitats.

Impacts of launch accidents on biological resources are discussed in Section 4.1.1.1.12.

4.1.1.1.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

4.1.1.1.8 Cultural Resources

Table 4-5 lists the historic facilities on KSC that may be used by the Constellation Program. It is expected that minor upgrades and modifications to historic ground processing and launch facilities currently being used for the Space Shuttle Program and International Space Station activities would occur at KSC. While some of these modifications would be minor and have little or no effect on the use or status of the properties, some would be major and constitute an adverse effect as defined in 36 CFR 800.5, *Protection of Historic Properties*. Some of those impacts identified to date include: the removal of the Fixed and Rotating Service Structures from LC-39 Pad B and potentially from LC-39 Pad A; modifications to the remaining Firing Rooms in the Launch Control Center; and modifications to the Orbiter Processing Facility to accommodate Ares V Upper Stage or lunar payload processing. Additional adverse effects to other properties may be identified as the Program matures.

Any Constellation Program activities that may have an adverse effect on these or other historic resources at KSC would be managed in accordance with the KSC Cultural Resources Management

Table 4-5. Proposed KSC Historic Facilities Supporting the Constellation Program

Government Facility	Proposed Use of Facility	Proposed Modifications to the Facility	Historic Status	Anticipated Adverse Effects to Historic Properties
Launch Complex-39, Pads A (Building J8-1708) and B (Building J7-0037)	Ares launch facilities	See Note at end of table. Demolition, modification, and rehabilitation of the launch complex.	NRHP and contributes to Historic District	Yes
SRB Assembly and Refurbishment facilities: Buildings 66250, L6-247, K6-494, L6-247, L7-251, 66251, 66240, 66242, 66244, 66310, 66320, 66249, and 66340.	Recovery and refurbishment of Ares I and Ares V launch vehicle elements.	Modification and rehabilitation of facility structures, features, and systems to handle higher throughput of Ares I First Stage and Ares V SRBs.	NRE (Buildings 66250, L6-247, and K6-494 only)	None
Missile Crawler Transporter Facilities	Crawlers used to transport Ares I and Ares V launch vehicles from VAB to launch pad	None currently identified	NRHP	None
Crawlerway	Roadbed used by crawlers to transport Ares I and Ares V launch vehicles between the VAB and launch pads	None currently identified	NRHP	None
Mobile Launch Platform(s)	Transport Ares V launch vehicles from VAB to launch pad	Modifications and rehabilitation of facility structures, features, and systems to support Ares V.	NRE	Possible
Launch Control Center (Building K6-099)	Launch control	Firing room 1 internal modifications including walls, ceilings, floors, HVAC, power, fire protection system.	NRHP	None
		Firing rooms internal modifications including walls, ceilings, floors, HVAC, power, fire protection system.	NRHP	Yes
Vehicle Assembly Building (VAB) (Building K6-0848)	Vehicle assembly and integration	Modification and rehabilitation of facility structures, features, and systems such as new high bay platforms, landing structures, utilities, *etc.*, to provide necessary access to assemble and integrate the Ares launch vehicles.	NRHP	Possible
Operations and Checkout (O&C) Building (Building M7-0355)	Orion assembly and integration	Modification and rehabilitation of facility structures, features, and systems such as new vacuum chamber and refurbishment.	NRHP	None
Orbiter Processing Facilities (OPFs) (Buildings K6-894 and K6-696)	Ares V Core Stage assembly	Modification and rehabilitation of facilities' structures, features, and systems, including processing stands.	NRE	Yes
Parachute Refurbishment Facility (PRF) (Building M7-0657)	Process and refurbish parachutes for SRB and Orion operations	None currently identified	NRE	None

NRHP = Asset is on the National Register of Historic Places (NRHP); NRE = National Register Eligible (asset is eligible for listing on the NRHP); NHL = National Historic Landmark;

Note: Modifications to Launch Complex-39 Pad B are addressed in the *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program at the John F. Kennedy Space Center Florida*. Future modifications to Launch Complex-39 Pad A and associated infrastructure are expected to be similar to those undertaken for Launch Complex-39 Pad B.

Plan and in consultation with the Florida State Historic Preservation Officer (SHPO). A Memoranda of Agreement (MOA) would be developed and implemented for such actions, as appropriate. Potential mitigation activities are discussed in Chapter 5 of this Final PEIS.

There are no known archeological resources at KSC associated with Constellation Program activities; therefore, no impacts to archeological resources are anticipated.

4.1.1.1.9 Hazardous Materials and Hazardous Wastes

KSC's use of hazardous materials and generation of hazardous waste depend on launch processing, construction, and associated activities. The primary materials consumed are typically chemical propellants (rocket fuels and oxidizers), pressurants and purge gases, solvents, and hazardous vent gas neutralization materials.

Processing and launch activities would generate hazardous waste streams from propellant servicing, launch operations, and recovery operations. Processing the Ares I First Stage and Ares V SRBs would be similar to ongoing operations for the Space Shuttle, except that Ares I and Ares V would involve processing five and 10 solid rocket motor segments per launch, respectively, compared to eight solid rocket motor segments per launch for the Space Shuttle. All processing and recovery operations involving the solid rocket motor segments would be within current hazardous waste permits. The hazardous materials used by the Constellation Program for launch vehicle processing and the quantities of hazardous waste generated would be expected to be similar to that used by the Space Shuttle Program.

The demolition and construction activities associated with any modifications to KSC facilities would possibly involve the use of hazardous materials and the generation of hazardous wastes; however, these would not be ongoing activities. These hazardous materials would be handled in accordance with current KSC practices and prescribed laws and regulations.

4.1.1.1.10 Transportation

Traffic levels on major roads and highways outside KSC are not expected to increase based on the Proposed Action. As with past NASA launches, KSC area vehicular traffic from workers and visitors would increase substantially on launch days when spectators would gather in the area to view the launch. No impacts to existing vehicular traffic levels within KSC would be expected.

The recovery and transportation of the spent Ares I First Stage and Ares V SRBs would follow Space Shuttle legacy procedures. However, the Constellation Program is studying the possibility of not recovering the spent Ares I First Stage and Ares V SRBs for certain missions. Under normal recovery procedures, the spent Ares I First Stage and Ares V SRBs would be recovered via ships and transported to KSC for preparation for shipping back to Alliant Techsystems-Launch Systems Group (ATK) in Utah for refurbishment. The spent solid rocket motor casings would be loaded into the sealed containers they were originally shipped in and returned to ATK via rail. Rail transportation has been used approximately 300 times to transport fueled Space Shuttle solid rocket motor segments from Utah to KSC. Each of these has been followed with a return trip and in approximately 10 instances, return trips have carried fueled solid rocket motor segments. These shipments have complied with all applicable Department of Transportation (DOT) regulations for rail shipment of hazardous materials. As such, minor rail incidents, such as train derailments, have not resulted in ignition of the solid propellant. See Section 4.1.2.1.11 for a discussion on transportation accidents involving fueled solid rocket motor segments.

Transportation of Constellation Program components between contractor sites, KSC, and other NASA Centers would be performed following Space Shuttle protocols where applicable, and could use rail, airplane, flat-bed truck, water vessel, or a combination thereof. All shipments would strictly adhere to DOT and Coast Guard regulations. Transportation of Ares I and Ares V launch vehicles to the launch pad after assembly would be similar to the current crawler transporter method used by the Space Shuttle Program.

4.1.1.1.11 Environmental Justice

On February 11, 1994, President William J. Clinton signed Executive Order (EO) 12898, entitled, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*. The general purposes of the EO are to: 1) focus the attention of Federal agencies on the human health and environmental conditions in minority and low-income communities with the goal of achieving environmental justice; 2) foster non-discrimination in Federal programs that substantially affect human health or the environment; and 3) give minority and low income communities greater opportunities for public participation in, and access to, public information on matters relating to human health and the environment.

EO 12898 directs Federal agencies, including NASA, to develop Environmental Justice strategies. Further, EO 12898 requires NASA, to the greatest extent practicable and permitted by law, to make the achievement of Environmental Justice part of NASA's mission. Disproportionately high adverse human health or environmental effects on minority or low-income populations must be identified and addressed. In response, NASA established an agency-wide strategy, which, in addition to the requirements set forth in the EO, seeks to: 1) minimize administrative burdens; 2) focus on public outreach and involvement; 3) encourage implementation plans tailored to the specific situation at each NASA Center; 4) make each NASA Center responsible for developing its own Environmental Justice Plan; and, 5) consider both normal operations and accidents (NASA 1995a). Each of the NASA Centers that would be involved in the Constellation Program have developed plans to comply with the EO 12898 and NASA's agency-wide strategy.

The Proposed Action is not expected to produce any consequences related to Environmental Justice. The proposed construction and launch activities at KSC would not be expected to generate pollutant emission levels or noise levels that would result in offsite adverse effects on human health and the environment. Construction activities would be implemented within the boundaries of KSC. The distance between the residential areas of Merritt Island and Titusville and the construction activity sites preclude any direct impacts to the public. In addition, due to remote location of the launch complexes, and by requiring launch trajectories to be over open ocean away from populated land areas, launch activities would not be expected to adversely impact human health in these communities. Launch accidents also pose no significant risk to the public. Toxic effects that could result from a liquid propellant spill during fueling operations would not extend beyond the immediate vicinity of the launch pad. Members of the public are excluded from the area at risk during launch operations. A fuel explosion on the launch pad or during the first few seconds of flight could temporarily increase the concentration of hazardous emissions outside of KSC/CCAFS boundaries. One-hour average concentrations of hazardous emissions from such an explosion would be expected to be less than the emergency response guidelines recommended by the American Industrial Hygiene Association and the National Research Council (USAF 1998). Implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the vicinity of KSC.

NASA would continue to consider Environmental Justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy. Any disproportionately high or adverse human health or environmental effects of the Constellation Program at KSC on low-income or minority populations would be identified and action would be taken to resolve public concern.

4.1.1.1.12 Launch Area Accidents

In the event of an anomalous launch, the point in the launch sequence when the failure occurs would determine the impact on the environment. The impacts of accidents that result in vehicle components hitting the ground on or near the launch pad or in the KSC vicinity are discussed in the following sections. Accidents that occur at higher altitudes and result in launch vehicle components falling into the Atlantic, Indian, and Pacific Oceans are discussed in Section 4.1.3.2.

An accident involving an Ares launch vehicle would produce air emissions and environmental impacts from the emissions similar in nature to those associated with normal launches. Specifically, emissions from a launch vehicle accident would not be expected to produce long-term environmental impacts, but rather local transient effects.

<u>KSC/CCAFS Range Safety</u>

A Range Safety process has been in effect since the establishment of NASA's launch facility at KSC in 1963 and parallels similar CCAFS processes. NASA's Range Safety Policy (NASA 2005c) is designed to protect the public, employees, and high-value property and is focused on the understanding and mitigation (as appropriate) of risk. The policy establishes individual and collective risk criteria for the general public (offsite public and onsite visitors) and onsite workforce for the risk of casualty from any means, including blast, debris, or toxic materials. KSC/CCAFS Range Safety protects people, as well as the range, by understanding the potential impacts of a launch area accident and establishing protection controls, including not launching if meteorological conditions might constitute a risk to the public in the event of a launch accident.

At KSC, the Range Safety process and the associated procedures ensure that:

- Direct impacts from launch accident debris are largely confined to the boundaries of KSC/CCAFS, and that those errant impacts are within acceptable limits
- Public risks are small, both from
  - Direct effects (via commanded destruction of errant launch vehicles)
  - Exhaust clouds (via launch constraints).

The most significant potential health hazard from an Ares I or Ares V launch accident outside the immediate vicinity of the launch pad would be the HCl emitted from burning solid propellant. Launch Range Safety uses models to predict launch hazards to the public and onsite personnel prior to every launch. These models calculate the risk of casualty resulting from HCl, debris, and blast overpressure from potential launch failures after accounting for local meteorological conditions. Launches may be postponed if the predicted collective public risk of injury exceeds approved levels (they may also be allowed to continue, given approval from the NPR 8715.5 designated authority, depending on the specific hazards posed and risk levels on the day of launch). This approach takes into account the probability of a catastrophic failure; the resultant hazard distributions for the principal Range Safety hazards (toxics, debris, and blast overpressure); and emergency preparedness procedures.

Program requirements and risk mitigation practices mandate the incorporation of commanded self-destruct systems on the Ares launch vehicles. In the event of destruct system activation, the propellant tanks and SRB casings would be ruptured and the propulsive capability of the entire launch vehicle would be rendered non-propulsive.

Emissions from a potential catastrophic event are routinely modeled by Range Safety in accordance with NASA's Range Safety policy. Part of this effort involves the modeling and evaluation of potential emissions by the USAF in their role as Range Safety Manager for the Eastern Test Range. While the bulk of potential risk from a launch vehicle accident is to the personnel and facilities at the launch site, a potential exists for emissions from a launch vehicle accident to reach surrounding communities. The USAF and NASA regularly coordinate with managers of the emergency preparedness organizations in the surrounding communities to review accident potentials and their associated impacts. This review establishes exposure limitations that, in conjunction with Range Safety policy, limit launch vehicle activity in periods where potential emissions could exceed the established criteria with local communities.

Models are tools that are used by safety and health professionals to aid in identifying potential impacts from an incident. While generally accepted, the modeling tools used to evaluate potential air emissions from a catastrophic launch incident are periodically updated and improved to reflect increased understanding and improved modeling capabilities. Any emissions model(s) utilized are or would be accepted by the USAF, NASA, and the launch risk community prior to its implementation. When these tools are approved for use, they would be applied to the Constellation Program launches as appropriate.

Potential Impacts of Ares I or Ares V Launch Area Accidents

An Ares I or Ares V launch vehicle accident either on or near the launch pad within a few seconds of liftoff presents the greatest potential for impact to the environment and human health, principally to visitors and workers. For either launch vehicle, a catastrophic accident on or near the launch pad would result in total destruction of the propulsive capabilities of the launch vehicle, through destruction of the Ares I First Stage or Ares V SRBs and the liquid propellant tanks.

Following a successful launch, after a few tens of seconds, the launch vehicle would be sufficiently far over the Atlantic Ocean that an accident occurring subsequently would result in components falling back to the ocean and presenting minimal threats to people or the environment. See Section 4.1.3.2 for the impacts of these accidents.

The impacts from a launch area accident can be due to several phenomena, including blast and fire, debris impacts, noise, and toxic combustion products from burning propellant.

Blast and Fire

In the immediate vicinity of the accident, a fireball from the ignition of the LOX/LH propellant would be expected, resulting in localized fires and other thermal effects. The burning solid propellant would be expected to induce similar localized fires. The explosion of a Delta II launch vehicle at CCAFS after launching on January 17, 1997 demonstrated that burning solid propellant could cause significant damage to facilities and structures with limited impacts to the natural environment. Vegetation burning occurred, but fires from lightning strikes are a part of the regenerative process in coastal scrub and strand ecosystems. The extensive cleanup of the debris left by the explosion reduced the potential longer-term impacts of the debris and unburned propellant in the vicinity of the Delta II launch pad (CCAFS 1998).

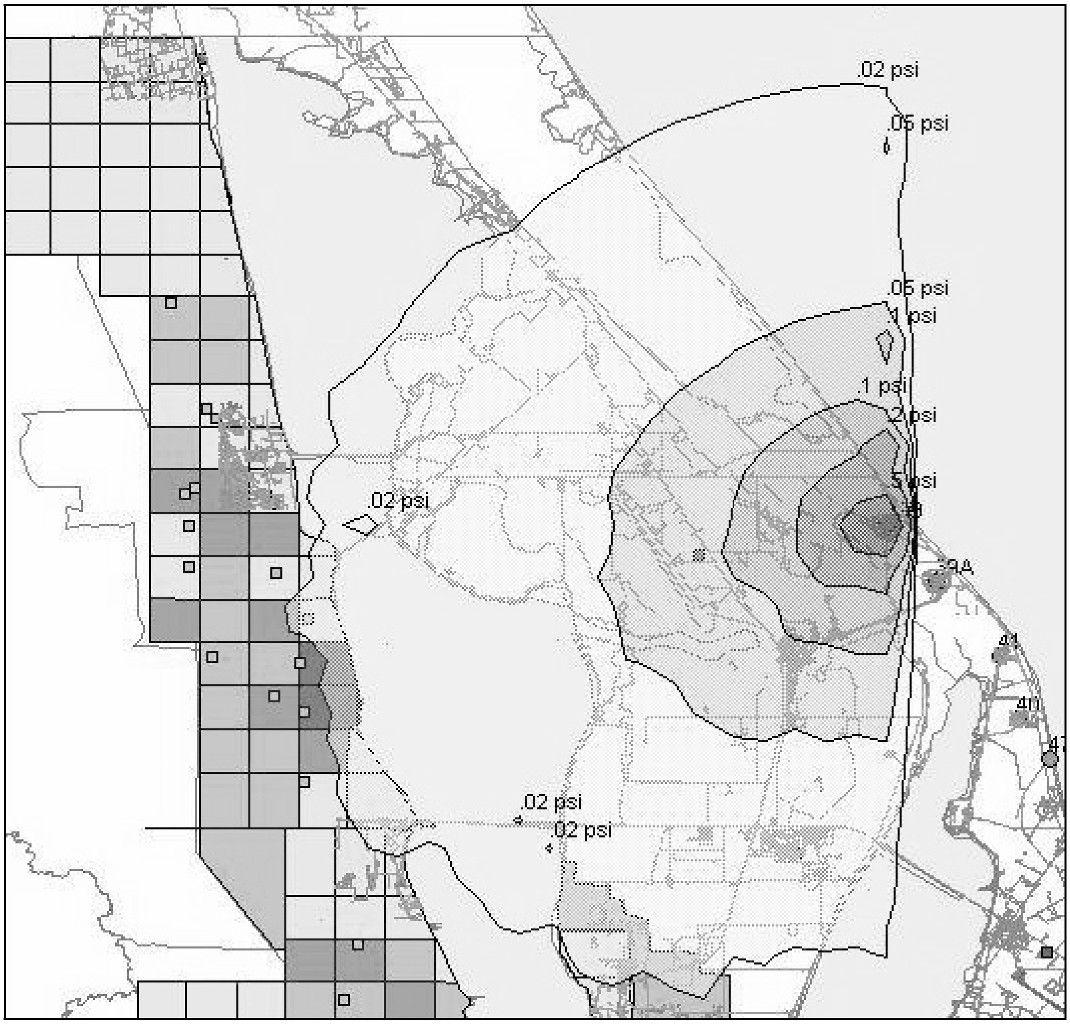
Depending on the nature of the launch vehicle accident, there could be a blast wave that would result in low-level, short-term overpressures out to several tens of kilometers. Threats to people or structures, however, would be limited to within a few kilometers of the blast.

Prior to each launch, Range Safety estimates the potential blast overpressures that might result from a catastrophic launch accident using the expected launch vehicle configuration. The calculations of the consequences of a catastrophic event consider a range of potential accident scenarios. These estimates are factored along with a number of other parameters to aid Range Safety in making the decision on whether to approve a launch. Figure 4-4 presents the results of one such calculation for a hypothetical accident during the December 2006 launch of the Space Shuttle mission STS-116 (USAF 2006). In this case, overpressures greater than 0.35 kPa (0.05 psi) (comparable to a public fireworks display from a viewing stand and sufficient to potentially cause damage to structures, including cracks in plaster and glass) would not be expected more than 10 km (6 mi) away from the blast.

Prior to an Ares I or Ares V launch, similar estimates of peak blast overpressures from hypothetical accidents would be made. Predicted peak overpressures from an Ares I or Ares V launch accident would be similar in character to those predicted for the Space Shuttle, but their absolute magnitude might vary, depending on the details of the accident assumptions and the final Ares I and Ares V vehicle designs. Pre-launch Range Safety modeling would ensure, however, that the risks to the range and public from these overpressures were controlled.

Debris

Range Safety also estimates the potential debris pattern that might result from a launch accident using the expected launch vehicle configuration. The calculations of the consequences of an accident consider a range of potential accident scenarios. Based on these calculations, Range Safety identifies areas within the launch area where debris may land following an accident. This may prompt the relocation of visitors and/or personnel prior to a launch and helps to ensure that risks to visitors and/or personnel and property from falling debris would be low for any accident. These estimates are also factored along with a number of other parameters to aid Range Safety in making the decision on whether to approve a launch.



Source: USAF 2006

Figure 4-4. Predicted Blast Overpressures for a Hypothetical Space Shuttle Launch Accident Scenario

Debris risks to onsite workers and visitors as well as to offsite areas and areas downrange under the flight path are calculated by Range Safety prior to each launch. For a typical Space Shuttle launch, onsite visitors face most of the debris risks from a Space Shuttle accident while offsite and downrange members of the public face a much smaller risk. The launch and ascent debris risks for Ares I and Ares V launches are expected to be similar to those estimated for the Space Shuttle. As with the Space Shuttle, prior to an Ares I or Ares V launch estimates of both onsite and offsite debris risks would be made by Range Safety. Debris risks from an Ares I or Ares V launch accident would be similar in character to those from the Space Shuttle, but their absolute magnitude might vary, depending on the details of the accident assumptions and the final Ares I and Ares V vehicle designs. Pre-launch Range Safety modeling would ensure, however, that the risks to the range and public from these overpressures were controlled.

Noise

There is very little information regarding noise levels during accidents. An explosion of a launch vehicle may produce significantly higher noise levels than those produced during normal operations. The USAF predicted a noise level of 200 dBA and an overpressure of 190 kPa (4,000 psf [28 psi]) at a distance of 33 m (100 ft) for a Titan IV/Centaur vehicle explosion (FAA 2001). However, the noise generated by an exploding Titan IV would not be representative of an Ares explosion, because the Titan IV core stage uses hypergolic propellants. In a failure, hypergolic propellants deflagrate (burn rapidly), rather than detonate, which produces less overpressure than the explosion of a launch vehicle employing solid fuel and cryogenic propellants (LOX/LH), such as an Ares launch vehicle. However, the destruct systems planned for the Ares I and Ares V should ensure that the vehicle propulsive components break up and burn rather than detonate. Thus, an accident involving an Ares would be expected to produce less noise than a smaller launch vehicle with hypergolic propellants as modeled by the USAF (FAA 2001).

Toxic Combustion Products

Any burning solid propellant that falls onto land would burn completely. Although Al_2O_3 would be deposited from a burning solid propellant exhaust cloud as it is carried downwind, little wet deposition of HCl would be anticipated from any burning solid rocket propellant. In the event of an accident on the launch pad, or very near the launch pad, the concentrations of HCl from the burning solid propellant could be expected to be in the same range as during a normal launch. These concentrations might be sufficient to damage or kill nearby biota.

The many variations in what might happen in a launch accident make predicting the maximum concentrations that might occur within a short distance (a few miles) of the pad difficult. However, these predictions are more straightforward when trying to estimate concentrations that might occur at a range of 8 to 16 km (5 to 10 miles) away, where spectators or the general public might be located. Range Safety could delay or cancel planned launches if meteorological conditions might constitute a risk to the public in the event of a launch accident.

The total amount of toxic material released from burning propellant following a launch accident would essentially be the same as is released in a normal launch. However, the burning propellant exhaust cloud would be concentrated in the area of the launch pad and solid propellant fire locations, rather than at the launch pad and along the flight trajectory as with a normal launch. If the accident occurs on or very near the launch pad, it is likely that the heat released by the burning solid propellant along with the heat released from a LOX/LH fireball would cause the solid propellant combustion products to rise to a high altitude. This would reduce close-in ground concentrations even though the quantity of solid propellant combustion products released at ground level would be greater than that released in a normal launch. The combustion products released at higher altitudes would travel much farther before settling back to the ground. This effect would tend to make the downwind concentrations of HCl, and other combustion products more like those from a normal launch. Specifically, the downwind concentrations of combustion products at a distance of several miles from an accident would be of similar magnitude to those for a normal launch.

Prior to each launch, Range Safety estimates the potential downwind air concentrations from both a normal launch and potential (hypothetical) accidents using real-time meteorology. Range Safety calculates the consequences of accidents considering a range of potential accident types, scenarios, and locations and then uses the range of possible weather conditions for the day and time of launch to predict the worst-case HCl concentrations that might result if a specific postulated accident occurred. These estimates are factored into a number of other parameters to aid Range Safety in making the decision on whether to approve a launch.

Various U.S. government agencies and industry groups have developed guidelines for potential short-term exposures to HCl by workers and the general public. These guidelines are summarized in Table 4-6.

Table 4-6. Guidelines for Exposure to HCl

Organization	Guideline	Criteria
National Research Council	Short-Term Public Emergency Guidance Level (SPEGL) (suitable concentrations for single, short-term, emergency exposures of the general public)	1 ppm
American Industrial Hygiene Association (AIHA)	Emergency Response Planning Guidelines (ERPG)-1: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing other than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor.	3 ppm
National Institute of Occupational Safety and Health (NIOSH)	Recommended Exposure Limit (REL) (ceiling must not be exceeded)	5 ppm
OSHA	Permissible Exposure Limit (PEL) (ceiling must not be exceeded)	5 ppm
AIHA	ERPG–2: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.	20 ppm
NIOSH/OSHA	Immediately dangerous to life and health (IDLH)	50 ppm
AIHA	ERPG–3: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing life-threatening health effects.	150 ppm

Source: NIOSH 2005

Table 4-7 and Figure 4-5 present the results of a potential downwind air concentration calculation for a hypothetical accident during the December 2006 launch of the Space Shuttle mission STS-116, provided as an illustrative case (USAF 2006). For this launch, a peak concentration of HCl of 7.1 ppm was predicted to occur approximately 11 km (6.8 mi) downwind, within KSC property. At that location, the exhaust cloud would pass in less than 10 minutes. As indicated in Table 4-6, a level of 5 ppm or less of HCl is considered acceptable by National Institute of Occupational Safety and Health (NIOSH) and OSHA for individuals to be exposed to on a routine basis in the workplace (NIOSH 2005). A level of 50 ppm is considered by NIOSH to pose an "Immediate Danger of Life and Health" and immediate actions would be needed to avoid harm (NIOSH 2005). In the case modeled, HCl levels in the downwind, offsite area would be less than 5 ppm, below levels of concern. Other criteria that could be used to indicate the potential for harm given short-term exposures to HCl have been developed by the American Industrial Hygiene Association (AIHA) in Emergency Response Planning Guides (ERPG). Their most restrictive classification, EPRG-1, sets a limit of 3 ppm while the ERPG-2 level, which is typically used for emergency planning situations, sets a guideline of 20 ppm.

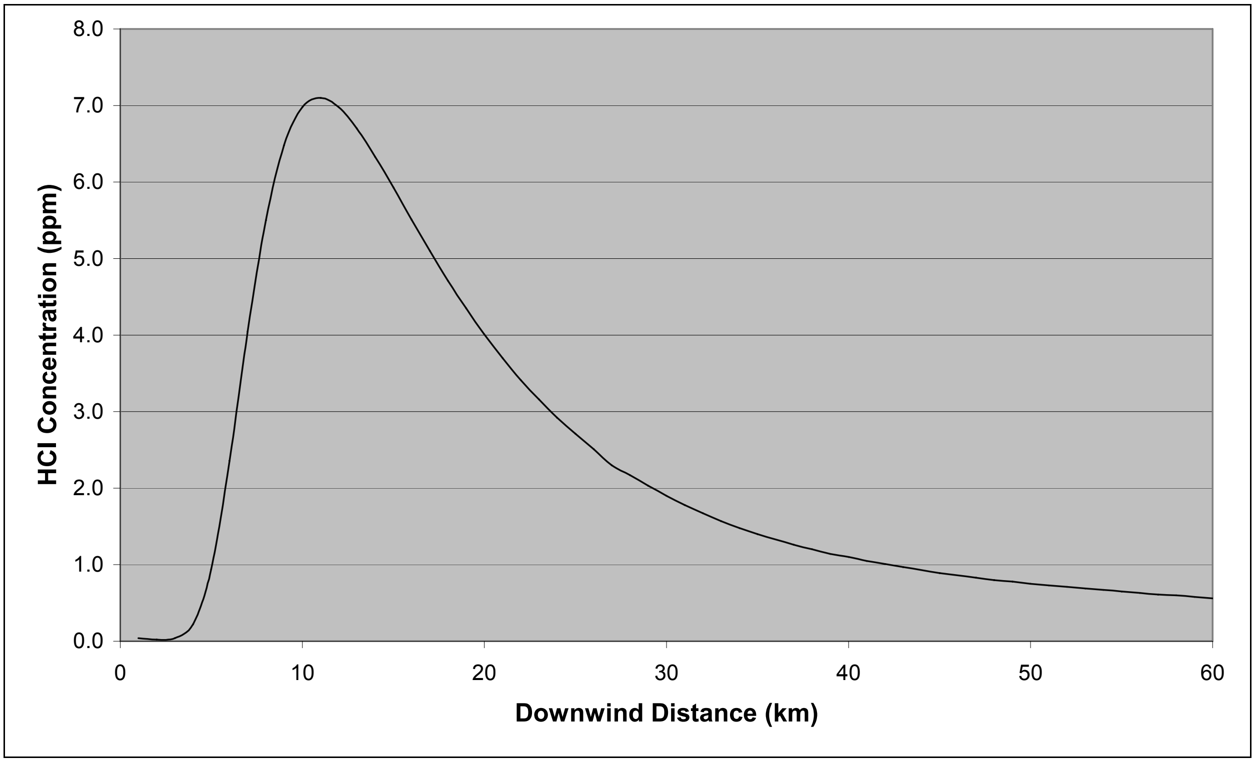
Table 4-7. Predicted Concentrations of HCl as a Function of Distance for a Hypothetical Space Shuttle Launch Accident Scenario

Distance from Pad (km)*	Peak HCl Concentration (ppm)	Exhaust Cloud Arrival Time (min)	Exhaust Cloud Departure Time (min)
1	0.04	0.0	2.5
2	0.02	0.0	4.3
3	0.04	0.2	7.0
4	0.22	2.0	10.4
5	0.94	3.7	12.2
6	2.36	5.5	13.9
7	4.05	7.3	15.7
8	5.50	9.0	17.5
9	6.48	10.7	19.3
10	6.98	12.4	21.1
12	6.98	15.9	24.6
14	6.33	19.4	28.2
16	5.51	22.9	31.8
18	4.71	26.3	35.4
20	4.01	29.7	39.0
22	3.41	33.2	42.6
24	2.92	36.6	46.2
26	2.51	40.0	49.9
28	2.17	43.5	53.5
30	1.90	46.9	67.1
35	1.40	55.5	66.2
40	1.10	64.0	75.2
45	0.89	72.6	84.3
50	0.75	81.1	93.4
55	0.65	89.7	102.5
60	0.56	98.2	111.6

Source: Adapted from USAF 2006

Notes: This table is provided for illustration purposes. Other meteorological conditions would result in different directions and concentrations. The wind direction (bearing from pad) is west-southwest (240 to 246 degrees).

* See conversion table on page xxiii to convert distance to miles.



Source: Adapted from USAF 2006

Figure 4-5. Predicted Peak Concentrations of HCl as a Function of Distance for a Hypothetical Space Shuttle Launch Accident Scenario

The estimated concentrations of combustion products at off-site locations resulting from postulated Space Shuttle accidents are well within applicable AIHA, NIOSH, and USAF guidelines/standards. It is also expected that emissions resulting from an accident during an Ares launch would not exceed any of the applicable guidelines/standards and would not create adverse impacts to air quality in the region, since the total amount of combustion products would be similar to that for a shuttle launch.

Potential Biological Impacts of Launch Area Accidents

Impacts on Vegetation and Wildlife—The results of a launch area accident, including extreme heat, fire, flying debris, and HCl deposition, could damage adjacent vegetation. Based on past experience from normal launches and launch accidents, damaged vegetation would be expected to re-grow within the same growing season because no lingering effects would be anticipated. The most sensitive nearby vegetative community, dune strand, was observed to sustain damage from a normal Space Shuttle launch, but recovered (CCAFS 1998).

The near-field impacts of accidents on vegetation and wildlife should be similar to the near-field impacts of normal launches. Observations of near-field impacts from launches have been documented following Space Shuttle launches. They include destruction of sensitive plant species followed by regrowth, a rapid drop in pH in nearby waters down to 1 m (3 ft) (resulting in fish kills) followed by a return to normal pH levels, and possibly deaths of burrowing animals in the path of the exhaust cloud or solid propellant fire plume (KSC 1985, CCAFS 1998).

Most if not all pieces of unburned solid propellant falling on land would be collected and disposed of as hazardous waste. Similarly, large, unburned pieces falling in shallow fresh water areas would be collected and disposed of as hazardous waste.

Birds, reptiles, and small mammals would be most at risk. Potential fires could result in temporary loss of habitat and mortality for species that do not leave the area. An accident on the launch pad would frighten nearby sensitive animal species that use the Indian and Banana Rivers (such as birds in rookeries and neo-tropical land birds). Threatened and endangered species, such as manatees, sea turtles, and other aquatic species would not be expected to be adversely affected by a launch accident.

Essential Fish Habitat and Managed Marine Species—Debris from launch failures has the potential to adversely affect managed fish species and their habitats. There are over 200 fish species that inhabit the waters in the vicinity of KSC that are currently managed by regional fishery management councils. NASA has consulted with the NMFS on essential fish habitat regarding launches of Ares vehicles from KSC (KSC 2007e). NASA indicated to NMFS that with over 25 years of Space Shuttle operations, there have been no documented long-term impacts to marine life or marine habitats from these operations. Similarly, the proposed Constellation Program launches are not expected to produce any measurable long-term impacts to marine species or habitats.

Potential Impacts on Ocean Environment

The predominant impacts of an early ascent accident or mission abort on the ocean environment would be due to unspent fuel and unrecoverable accident debris. The magnitude of the impact would depend on the physical properties of the materials (*e.g.*, size, composition, quantity) and the physical oceanography of the impact region. It is expected that the components would slowly corrode. Toxic concentrations of metals would be unlikely because of slow corrosion rates and the volume of ocean water available for dilution (USAF 1996, NASA 2006d).

Falling launch vehicle fragments would be unlikely to strike a marine mammal due to the extent of the open ocean and the relatively low density of marine mammals in the surface waters of open ocean areas (USAF 1998).

Search and recovery operations would be expected to be similar to ongoing and past Space Shuttle operations that recover the SRBs. These types of operations have a negligible effect on the ocean environment.

See Section 4.1.3.2 for information on impacts of un-burned propellant on the ocean environment.

Potential Generation of Hazardous Materials

Recovered solid debris from a launch accident would be removed from coastal ocean and/or river environments, and treated as hazardous waste in accordance with Federal, state, and local regulations. After the explosion of the Delta II on January 17, 1997, an extensive cleanup of the debris left by the explosion reduced the potential longer-term impacts of the debris and unburned propellant (CCAFS 1998). Short-term impacts to the near-shore environments could result from debris generated by an Ares launch accident, but long-term impacts are not expected to be significant. Adherence to permit requirements and applicable regulations would minimize adverse impacts to water quality; therefore, no mitigation measures would typically be necessary.

4.1.1.2 John C. Stennis Space Center

Table 4-8 summarizes the major activities currently anticipated at the John C. Stennis Space Center (SSC) in support of the Constellation Program.

Table 4-8. Description of Constellation Program Activities at SSC

Constellation Program Project	Project Responsibilities
Project Ares	Management and integration for rocket propulsion testing Sea level and altitude development, certification and acceptance testing for Upper Stage J-2X engine Ares V cluster testing Ares V RS-68B engine testing Support altitude development and certification testing for Upper Stage J-2X engine.
Ground Operations Project	Support: • Design, development, testing, and evaluation of propellant test and delivery systems • Ground engine checkout facility simulation and analysis • Engine and launch facility planning and development

At SSC, most of these reasonably foreseeable activities would be similar to ongoing activities conducted in support of the Space Shuttle Program. As such, the environmental impacts of implementing the Constellation Program at SSC would be expected to be similar to the environmental impacts from the ongoing Space Shuttle Program, which have been documented in various environmental documents including the SSC Environmental Resources Document (SSC 2005).

The principal activity at SSC in support of the Constellation Program would be full-scale ground testing of the LOX/LH liquid engines to be used on Ares I and Ares V launch vehicles. For Ares I and Ares V, this includes the J-2X Upper Stage engine, with approximately 1.3×10^6 Newton (N) (300,000 lbf) thrust (in vacuum). These engines would be similar to the Space Shuttle main engines, which provide approximately 1.7×10^6 N (397,000 lbf) thrust (at sea level) each, which are routinely tested at SSC. In addition, individual 3.1×10^6 N (688,000 lbf) thrust (at sea level) RS-68B Core Stage engines for the Ares V would be tested, and the cluster of RS-68B engines that would collectively serve as the Ares V Core Stage engines.

Several of the facilities at SSC identified for potential use in the Constellation Program may require modification. Many of the modifications would be modest such as internal upgrades to electrical wiring and moving interior walls; however, some modifications would be more extensive. Table 2-10 summarizes new facility construction and modifications being considered to support the Constellation Program where the modifications might impact historic facilities or have the potential for environmental impacts sufficient to require additional analysis under an

EA or an EIS. See Section 4.1.1.2.8 for discussion of historic/cultural impacts associated with the construction activities at SSC.

Engine testing activities for the Constellation Program would occur within the SSC Rocket Propulsion Test Complex, which includes the A-1 Test Stand, A-2 Test Stand and B-1/B-2 Test Stand Complex. The A-1 Test Stand is currently being prepared for testing the J-2X power pack and J-2X engine at sea level conditions. The B-1/B-2 Test Stand Complex possibly would be prepared for Ares V RS-68B single and Core Stage engine testing. These test stands are currently used to support other engine testing programs.

Test Complex "A" includes two single position test stands, a test control Center, observation bunkers and support systems for high-pressure gas (air, helium, nitrogen), water, electrical power, and propellants (LOX/LH). Test Complex "B" includes one dual position test stand, a test control Center, machine shop and docking and fuel transfer capabilities for liquid propellant barges. The B-2 Test Stand would require modifications in order to test the Ares V Core Stage engine cluster.

NASA is proposing to operate a new test stand (A-3) (currently under construction) in order to test J-2X engines in a vacuum, simulating altitude conditions. The environmental impacts of this new test stand are evaluated in detail in the *Final Environmental Assessment for Construction and Operation of the Constellation Program A-3 Test Stand, Stennis Space Center, Hancock County, Mississippi* (SSC 2007b). The test stand, currently called the A-3 Test Stand, would be used to test rocket engines capable of 1.3×10^6 N (300,000 lbf) thrust at a simulated altitude of approximately 30,480 m (100,000 ft). To achieve the simulated altitude environment, chemical steam generators using isopropyl alcohol, LOX, and water would run for the duration of the test and would generate approximately 2,096 kg (4,620 lbs) per second of steam to reduce the pressure in the test cell and downstream of the engine. The propellants used to test the engines would be LOX and LH. The test stand would include all systems required to run an engine test including propellant run tanks and replenishment barges. The engine to be tested would be located in a vacuum test cell at the top of the exhaust duct and would fire into a diffuser which would direct the engine exhaust away from the test stand. Gaseous nitrogen, helium, and hydrogen would be supplied to the test stand from existing onsite supply systems. The exhaust duct would be cooled by water supplied by the onsite high pressure industrial water distribution system. All water used for cooling or fire suppression would be contained in a new site retention pond.

The most notable environmental impacts from the construction and operation of the test stand would be air emissions from isopropyl alcohol and LOX/LH chemical steam generators, wetlands disturbance, noise from engine testing, cooling water usage, storm water runoff and ground water usage.

Figure 4-6 illustrates the principal anticipated activity at SSC, testing of LOX/LH engines such as the RS-68B and J-2X. Emissions from combustion of LOX/LH are primarily water vapor.

Figure 4-6. Testing of a LOX/LH Fueled Rocket Engine at SSC

4.1.1.2.1 Land Resources

Activities described under the Proposed Action would not conflict with current land use plans at SSC. The proposed activities are similar to previous uses for the Space Shuttle and other programs. The proposed modifications to existing test stands would not be expected to utilize previously undisturbed land areas or be expected to impact any undisturbed wetland areas. There are no coastal areas or essential fish habitats within the Center's boundaries.

The new A-3 Test Stand is being constructed on a site 0.40 km (0.25 mi) south of the A-1 Test Stand in an area designated in the SSC Master Plan for Medium Propulsion System Testing. The construction site is approximately 10 hectares (ha) (25 acres [ac]) located next to the SSC Access Canal. See Section 5.1.2 for a discussion of wetland mitigation measures at SSC associated with the construction of the A-3 Test Stand.

4.1.1.2.2 Air Resources

In support of the Constellation Program, air emissions at SSC would likely be generated from liquid rocket engine testing. The air quality impacts of engine testing were extensively evaluated in the *Final Environmental Impact Statement of Engine Technology Support for NASA Advanced Space Transportation Program*, referred to as the *Engine Technology Support EIS* in this Final PEIS (MSFC 1997a). That EIS evaluated the air impacts of liquid rocket engine testing for large, medium, and small thrust engines, as well as clusters of five large-thrust engines, three medium-thrust engines, and seven small-thrust engines. Most of these engines used a kerosene based fuel (RP-1) and LOX, and hence would emit a range of pollutants not expected with

LOX/LH engine testing. Emissions from the Constellation Program engine tests (see Table 2-11) would be expected to be primarily water vapor, with some NO_x emissions from the high-temperature combustion of atmospheric nitrogen gas. Other permitted air emission sources at SSC (diesel generators, fuel dispensing, Freon® recovery, abrasive blasting, flare stacks, and other rocket test stands) would be assumed to continue at the same level of activity as the Space Shuttle Program and other ongoing SSC programs.

Testing of LOX/LH rocket engines is not expected to generate emissions of criteria or hazardous air pollutants other than NO_x. The quantities of NO_x would vary based on rocket nozzle configuration, but would be within the limits allowed under the Clean Air Act (CAA) Title V operating permit for SSC. Based on the *Engine Technology Support EIS* (MSFC 1997a), which bounds planned Constellation Program test types, frequency, and engine size, the maximum quantity of NO_x produced from engine testing processes is expected to be less than 0.9 metric ton (mt) (1 ton) per day.

Preliminary estimates for potential air emissions from the A-3 Test Stand indicate that for a 650-second test, the total amount of CO to be released would be 31.8 mt (35.1 tons). NASA would perform up to two rocket engine tests on the A-3 Test Stand each month during the peak development timeframe (2009-2011). This would correspond to an annual release of up to approximately 637 mt (702 tons) of CO (SSC 2007b).

Additionally, the new facility would require two flare stacks for burning excess hydrogen. The flare stacks would use natural gas or propane for ignition. The addition of these emission sources are considered an operational flexibility change to SSC's Title V Operating Permit and would require notification to the Mississippi Department of Environmental Quality (MDEQ).

Air emissions from the construction of the A-3 Test Stand include short-term fugitive air emissions from construction activities. Dust from the site is controlled using SSC best management practices.

The ambient air quality of the three southern-most Mississippi counties (Hancock, Harrison and Jackson) is considered to be in attainment or unclassifiable with the National Ambient Air Quality Standards (NAAQS) for all criteria pollutants.

SSC currently holds a Title V Permit to Operate Air Emissions Equipment (number 1000-00005) issued by the MDEQ. This permit includes all existing air emission points at SSC including rocket engine and component test stands, diesel-fueled generators and pumps, fuel storage tanks, and flare stacks. NASA operations at SSC are considered to be a "major source" of air emissions because the potential emissions from the test facility exceed the 100 tons per year CAA criteria for air permitting.

Modifications to major sources are considered major modifications if they will increase the potential to emit by more than the Prevention of Significant Deterioration (PSD) annual significant emission threshold (100 tons per year for CO) or if they increase the potential to emit by any amount if the source is located within 100 km (62 mi) of a Class I area and the impact would be greater than 1 $\mu g/m^3$ (24-hour average) in the Class I area. The nearest PSD Class I area is the Breton National Wildlife Refuge in Louisiana which is located approximately 80 km (50 mi) from the test stand areas.

Since emissions from the A-3 Test Stand at the projected peak test schedule of two tests per month would exceed the 100 tons per year threshold, SSC performed a PSD review of this action. SSC prepared and submitted a PSD permit application to the MDEQ and consulted with the Federal Land Manager of Breton National Wildlife Refuge. The PSD permit review included a public comment period during which the public, the Environmental Protection Agency, and any other interested party could provide remarks to the MDEQ; no public comments were received. NASA has received the necessary permits and has begun the construction of the A-3 Test Stand. The proposed changes would also be reflected in the Title V Operating Permit renewal application due to the MDEQ no later than April 30, 2008.

4.1.1.2.3 Water Resources

Potential environmental impacts to surface water resources at SSC would principally be associated with rocket engine testing. SSC is permitted by the State of Mississippi to divert or withdraw water for beneficial use from the Access Canal. The canal is the primary source of water for the 250 million l (66 million gal) industrial water reservoir, which is used to provide water for fire protection and diffuser cooling water for the test stands. No additional cooling water storage would be required to meet Constellation Program testing needs. After use, the cooling water is discharged into the SSC canal system. Thermal studies of the current engine testing programs have not indicated any impact on the canal system associated with discharge water temperatures. Water from the canal is directed to the East Pearl River through a lock system. A spillway and overflow of the canal drains into Devil’s Swamp, which discharges into Bayou LaCroix and the Bay of St. Louis to the Mississippi Sound (MSFC 1997a). Wastewater effluent from Constellation Program engine testing would be discharged to surface waters under a state discharge permit. Under the current permit, monitoring of these discharges would not be necessary.

SSC currently holds a MDEQ Large Construction Storm Water Permit and a U.S. Army Corps of Engineers wetlands disturbance authorization for the construction of the A-3 Test Stand, and a Mississippi Department of Marine Resources Waiver for construction of a bulkhead and mooring dolphins. SSC is preparing to apply for a MDEQ 401 Water Quality Certification and a U.S. Army Corps of Engineers 404 Permit to begin work within the SSC Access Canal. SSC is required to have a MDEQ National Pollutant Discharge Elimination System Permit to operate the A-3 Test Stand for the outfall of deluge water and steam condensate prior to commencing operations (SSC 2007d).

It is expected that any addition of workers in support of the Constellation Program would not overburden the sanitary wastewater treatment systems at SSC or increase the potable water demand beyond current system capacity. Potable water usage would increase during operation of steam generators at the new A-3 Test Stand. Thermal waste water release from A-3 Test Stand would be regulated.

The impacts of expanded engine testing on water resources at SSC were extensively evaluated in the *Engine Technology Support EIS* (MSFC 1997a). The Constellation Program engine testing activities proposed for SSC would be bounded by the engine testing activities evaluated in the *Engine Technology Support EIS*. Based on those analyses, the proposed Constellation Program testing would not result in wetland or floodplain disturbance.

The potential for groundwater, surface water, or wetland impacts from accidental propellant and/or other material spills, such as LOX/LH and isopropyl alcohol, would be minor. Any spills would be minimized through compliance with all applicable spill prevention and control requirements. No wetlands impacts other than those associated with construction of the A-3 Test Stand are anticipated. Deposition of particles from engine exhaust during test firings is anticipated to be an insignificant impact to the overall quality of wetland and floodplain areas.

No adverse impacts to floodplains at SSC would be expected as a result of the proposed Constellation Program activities.

4.1.1.2.4 Noise

Construction activities associated with the A-3 Test Stand will have negligible noise impacts away from the construction site due to the large size of SSC and the Buffer Zone.

Testing of individual 2.9×10^6 N (660,000 lbf) thrust (at sea level) RS-68B LOX/LH engines would likely occur on the B-1 Test Stand. Testing of 1.3×10^6 N (300,000 lbf) thrust (in vacuum) J-2X LOX/LH engines would likely occur on the A-1 Test Stand with Upper Stage engine vacuum testing at the A-3 Test Stand. Testing of five engine RS-68B LOX/LH clusters (the current planning configuration for the Ares V Core Stage), each with a combined thrust of approximately 16×10^6 N (3.5×10^6 lbf) (at sea level), would likely occur on the B-2 Test Stand.

The SSC test stands that would be used for the Constellation Program are located in the central portion of SSC and oriented to the north-northeast in a manner that directs sound to the north and east. Noise impacts from single-engine tests would be expected to be minimal. The test stands are well within the acoustic Buffer Zone surrounding SSC. The B-1/B-2, A-1 and A-2 test stands are currently being used for testing Space Shuttle main engines and were previously used for testing Saturn F-1 engines, including a cluster of five F-1s on the B-1/B-2 Test Stand with a combined thrust of approximately 33×10^6 N (7.5×10^6 lbf). Other engines, including the RS-68, also have been tested at these stands in recent years.

The noise impacts of engine testing were extensively evaluated in the *Engine Technology Support EIS* (MSFC 1997a). That EIS evaluated the noise impacts of liquid rocket engine testing for large (12×10^6 N [2.6 million lbf]) thrust, medium (3.6×10^6 N [816,000 lbf]) thrust, and small (1.7×10^6 N [386,000 lbf]) thrust engines, as well as clusters of five large-thrust engines, three medium thrust engines, and seven small thrust engines. Although the actual noise produced by a rocket engine is a function of several parameters, including thrust, specific impulse, exhaust velocity, throttle exit diameter, acoustic efficiency, and mechanical power, the noise generated generally scales with overall engine thrust. Thus, the noise from a single 1.3×10^6 N (300,000 lbf) thrust J-2X engine test or single 3.1×10^6 N (660,000 lbf) RS-68B engine test would be bounded by the noise generated by one 3.6×10^6 N (816,000 lbf) medium-thrust engine. Noise from the testing of a cluster of five RS-68B engines (the current planning configuration for the Ares V Core Stage), with a combined thrust of approximately 16×10^6 N (3.5 million lbf) (at sea level), would be bounded by the modeled noise impacts for the Saturn-like five F-1A engine cluster with a combined thrust of approximately 33×10^6 N (7.5×10^6 lbf). Noise from larger clusters of RS-68B engines should also be less than that modeled for the Saturn V cluster as the overall thrust is substantially lower than the Saturn cluster. Noise modeling performed for the *Engine Technology Support EIS* therefore envelopes the offsite sound pressure levels that would be expected with engine testing proposed to support Ares I and Ares V development (MSFC 1997a).

Rocket engines produce predominantly low-frequency noise, which is particularly discernable several kilometers away from the engine(s). The human auditory system does not respond to this low frequency noise as much as it does to noise containing higher frequencies. The low-frequency sound is, however, detectable in the form of vibration in building walls and windows. Thus, two aspects of rocket engine sound are evaluated by NASA: low frequency sound that vibrates buildings and high frequency sound that is audible to humans (SSC 2005). NASA has determined, based on experience from previous testing programs at the George C. Marshall Space Flight Center (MSFC) and at SSC that the levels of significance within the respective communities are approximately 100 dB (OASPL) for low frequency noise and 70 dBA for high frequency noise (SSC 2005).

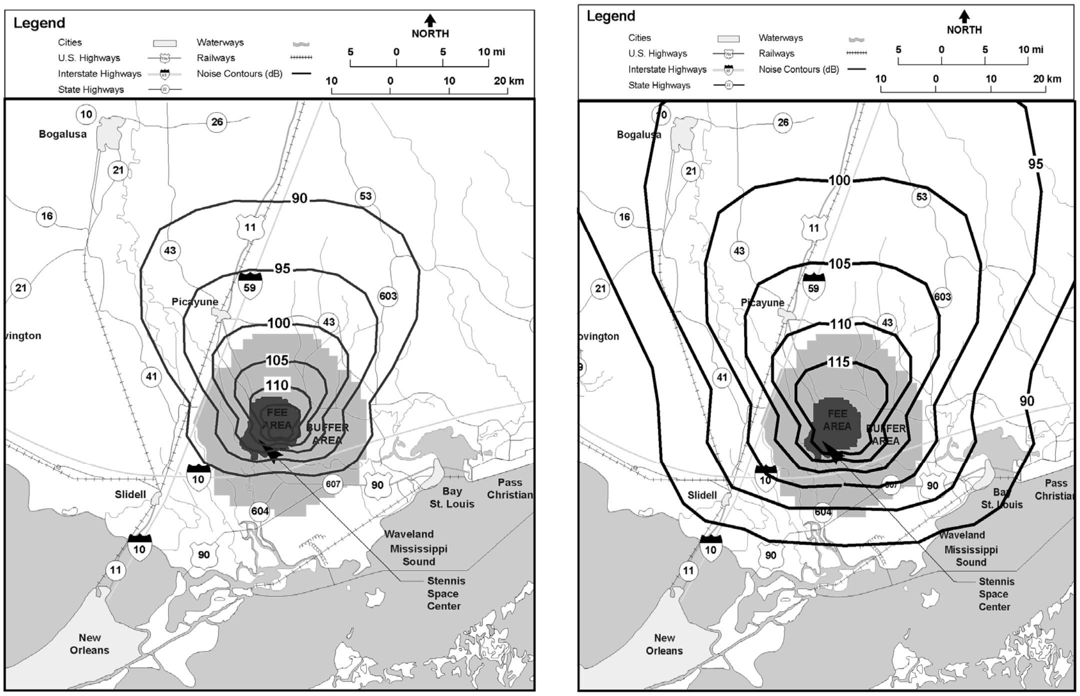
<u>Operational Noise Predictions</u>

Noise levels from testing large, medium, and small-thrust engines, and clusters of engines were modeled in the *Engine Technology Support EIS*. The results were reported in terms of OASPL (measured in dB) contours which did not take ground effects into account (ground effects would reduce noise levels). In addition, the modeling assumed no acoustic focusing of the noise due to unusual meteorological conditions.

The OASPL contours from the *Engine Technology Support EIS* for the medium-thrust engine (which bounds the RS-68B) and the five-large engine cluster (which bounds the current concept for the Ares V Core Stage RS-68B cluster) are shown in Figure 4-7. These noise contours were generated for the same A- and B-area test stands to be used for the Constellation Program tests. The maximum offsite OASPL for firing a cluster of five large engines was estimated to be 112 dB, at the northwestern edge of the Buffer Zone at SSC. At these levels, the chances of structural damage would be less than 0.2 percent or less than two per thousand households (MSFC 1997a).

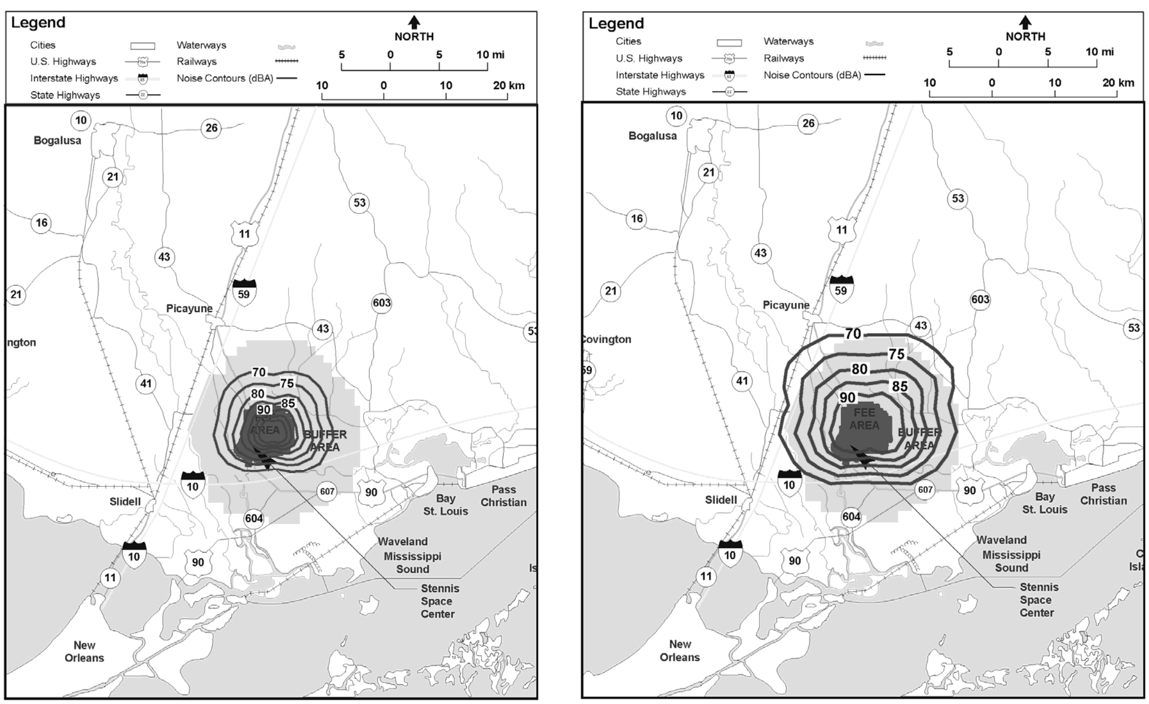
The dBA contours from the *Engine Technology Support EIS* for a single medium-thrust engine test and a test of a cluster of five large-thrust engines are shown in Figure 4-8 (MSFC 1997a). Table 4-9 summarizes the predicted noise levels. The highest offsite noise levels would be generally in a northerly direction.

These predicted noise levels, which were expected for six to seven minutes in some tests, were similar in magnitude to previous engine tests and were not expected to have a major impact on the population outside the Buffer Zone. Based on these noise levels, the *Engine Technology Support EIS* concluded that “all noise impacts are predicted to be small with the exception of the large multiple engine testing which would be considered a moderate impact.” Since the engine testing in support of the Constellation Program would be bounded by the testing modeled in the *Engine Technology Support EIS*, the same conclusion is applicable with regard to Constellation Program engine testing at SSC.



Source: MSFC 1997a

Figure 4-7. Sound Level Predictions (dB) for Testing One Medium-Thrust Engine (left) and Five Large-Thrust Engines (right) at SSC



Source: MSFC 1997a

Figure 4-8. A-Weighted Sound Level Predictions (dBA) for Testing One Medium-Thrust Engine (left) and Five Large-Thrust Engines (right) at SSC

Table 4-9. Maximum SSC Offsite Noise Levels

Engine	dBA	dB	Direction
Medium engine (bounds RS-68B)	65	103	North
Saturn-like cluster of five large engines (nearly twice the thrust of and bounding the Ares V cluster of five RS-68B engines)	77	112	North
J-2X on A-3 Test Stand	77	96	Southeast

Source: Adapted from MSFC 1997a, SSC 2007b

Noise that would be produced from testing the J-2X engine, including the two stages of steam ejectors, on the A-3 Test Stand would be similar to the noise generated by Space Shuttle Main Engine tests that frequently occur at SSC but would be directed toward the south-east of the test stand through a 7 m (23 ft) diameter diffuser. The A-weighted sound pressure level at the edge of the Buffer Zone, 10.6 km (6.6 mi) from the A-3 Test Stand site is predicted to be approximately 77 dBA. Modeling of estimated sound generation predicts that the OASPL at the edge of the Buffer Zone would be approximately 96 dB. At this level the chance of structural damage outside of the SSC Buffer Zone would be negligible (SSC 2007b). Predicted J-2X values are shown in Table 4-9 for comparison with calculations from the *Engine Technology Support EIS* which bound noise levels from RS-68B engine tests. Maximum potential J-2X engine test frequency for the A-3 Test Stand would be two full duration tests per month for 650 seconds (10.8 minutes) each; for a collective total of 15,600 seconds (4.3 hours) per year.

Impacts of Noise on the Environment

Due to its large acoustical Buffer Zone, SSC was the only NASA test location considered suitable for multiple engine testing in the *Engine Technology Support EIS* Record of Decision (ROD) (MSFC 1998) for tests in which total thrust would exceed that of one large engine. The *Engine Technology Support EIS* concluded that noise impacts at SSC are expected only with large-thrust multiple engine tests.

Noise from Constellation Program engine tests at SSC would generally be similar to ongoing tests of the Space Shuttle Main Engines and the Delta IV RS-68 engine. Only the tests of the RS-68B cluster proposed for the Ares V Core Stage would potentially produce noise levels that exceed ongoing test activities. Noise levels for cluster tests would be expected to be similar to those experienced with Saturn V main engine testing between 1966 and 1970 and could result in similar noise impacts and complaints.

Health Effects

With the occupational noise controls that are already in place at SSC to protect workers from noise-related health effects from ongoing engine tests, no additional noise-related health effects among the workforce would be expected to occur during the Constellation Program engine testing activities.

As indicated in Table 4-9, the maximum predicted offsite noise levels would be 77 dBA during the Constellation Program engine testing. Offsite noise levels of 77 dBA for approximately

11 minutes would be much lower than the 85 dBA 8-hour exposure threshold at which OSHA requires a hearing conservation program (29 CFR 1910.95). Offsite-noise levels would also be much lower than levels at which OSHA would require hearing protection or engineering controls for workers. OSHA requires hearing protection or engineering controls be applied if workers are exposed to sound levels greater than 115 dBA for more than a quarter of an hour (29 CFR 1926.52). Therefore, no hearing effects among the general public would be anticipated.

Structural Damage Claims

The probability of structural damage from engine tests, as indicated by damage claims submitted by the public, has been found to be proportional to the intensity of the low-frequency sound. One claim in 10,000 households is expected at a level of 103 dB, one in 1,000 households at 111 dB, and one in 100 households at 119 dB (MSFC 2002a). The maximum predicted offsite noise levels for Constellation Program testing would be 103 dB for a medium engine and 112 dB for a five-engine cluster during the few minutes of engine testing (See Table 4-9). These levels indicate that as with the testing of the Saturn V engines, some structural damage to offsite structures might occur (SSC 2007b).

Speech Interference

Speech interference can occur at ambient noise levels above approximately 70 dBA, where people engaged in conversation outdoors would have to speak louder or move closer together to continue the conversation. In some locations, the noise level would be above 70 dBA during the brief Constellation Program engine tests and conversation would be momentarily interrupted. However, tests would be of short duration (J-2X test durations would be nearly 11 minutes, five cluster RS-68B test durations would be 5.5 minutes) and would be infrequent. The impacts of speech disruptions would be minimal.

Sleep Interference

Interference with sleep can occur at noise levels as low as 35 dBA. Daytime testing activities would not interfere with nighttime sleeping patterns. People who sleep during the day must normally learn to sleep with a greater level of exterior noise. At noise levels of 65 dBA (for single engine tests) and 77 dBA (for five engine cluster tests) during Constellation Program engine tests, some interference with daytime sleepers would be expected. However, due to the infrequency of tests and their short duration (less than 11 minutes), the impact would be expected to be minimal.

Mitigation

In the ROD for the *Engine Technology Support EIS* (MSFC 1998), NASA committed to take certain positive actions to mitigate the potential offsite noise impacts of testing large engines at SSC, including evaluating the potential for acoustic focusing. NASA would continue to follow those mitigative measures for Constellation Program engine testing at SSC. Details on mitigation measures are provided in Chapter 5 of this Final PEIS.

4.1.1.2.5 Geology and Soils

No substantial impacts to geology or soils would be expected from refurbishing the existing test stands, constructing the A-3 Test Stand, or operating the test stands. Dust resuspension from engine testing and subsequent particulate deposition could be expected; however, no adverse impacts would be anticipated.

4.1.1.2.6 Biological Resources

Constellation Program activities would not be expected to adversely impact any protected wetlands or biological resources at SSC, including Federal and state-protected species, state ranked species, and habitats. Engine testing noise and vibration would be expected to temporarily disturb wildlife in nearby areas, with some vacating the area for the duration of a given test. These effects have been observed to be temporary over the long history of engine testing at SSC.

No Federal or state-listed or state-ranked species or critical habitat has been observed in the engine test area. If a listed or ranked species is identified, the U.S. Fish and Wildlife Service would be consulted and a management procedure would be implemented.

Disturbance of the site for the A-3 Test Stand is not expected to have substantial impacts on wildlife in the area. Wildlife habitat in the immediate area of the test stand is considered marginal because of the present use of this facility complex. The site may be a suitable foraging area for various species such as deer, mice, song birds and raptors, however, activity associated with current engine tests limits its suitability as a nesting or roosting habitat (SSC 2007b).

A visual inspection of the site for the A-3 Test Stand was conducted on March 16, 2007 by a Mississippi State University research group. This was requested by the U.S. Fish and Wildlife Service prior to any earth or vegetation disturbance. No known Federal or state listed species or habitats were found. Therefore, based on prior studies, inspections, and U.S. Fish and Wildlife Service concurrence, there would be no effect on threatened and endangered species from the construction and operation of the A-3 Test Stand (SSC 2007b).

SSC manages wetlands within the facility in accordance with 14 CFR 1216.205, *Policies for Evaluating NASA Actions Impacting Floodplains and Wetlands*. In planning mitigation activities associated with development of the new A-3 Test Stand for the Constellation Program, SSC has delineated 118.54 ac (47.9 ha) wetlands credits (based on the U.S. Army Corps of Engineer's Charleston Method) which would be charged against its "Mitigation Bank."

4.1.1.2.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

4.1.1.2.8 Cultural Resources

Table 4-10 lists the historic facilities on SSC that may be used by the Constellation Program. Modifications of the A-1 Test Stand (Building 4120) needed to support early developmental tests have been documented and mitigated through the Section 106 process completed with the Mississippi SHPO in November 2006. Additional consultation would be necessary regarding future actions involving the National Historic Landmarks at SSC, such as modifications to the B-2 Test Sand (Building 4220).

Table 4-10. Proposed SSC Historic Facilities Supporting the Constellation Program

Government Facility	Proposed Use of Facility	Proposed Modifications to the Facility	Historic Status	Anticipated Adverse Effects to Historic Properties
A-1 Rocket Propulsion Test Stand (Building 4120)	Ares I J-2X power pack and J-2X Upper Stage engine testing and Ares V J-2X Earth Departure Stage engine testing	Minor upgrades and reconfiguration	NHL	None
A-2 Rocket Propulsion Test Stand (Building 4122)	J-2X engine component testing	Minor repairs and modifications	NHL	None
B-1 Test Stand (Building 4220)	Ares V RS-68B engine testing	None currently identified	NHL	None
B-2 Test Stand (Building 4220)	Ares V RS-68B Core Stage engine testing	Major structural modifications – support structure, refurbishment, upgrades to structural steel	NHL	Possible

NHL = National Historic Landmark

An area bounded by streets and including the old town site of Gainesville is NRHP-eligible and has been nominated for listing in the NRHP. Located 4.8 km (3 mi) from the Test Stand area and in the southwest part of SSC, this district would be affected by noise from Constellation Program test activities. In addition, NASA-owned land within Logtown is potentially NRHP-eligible. This district would also be affected by the noise from Constellation Program test activities.

Any Constellation Program activities that may have an adverse effect on these or other historic resources would be managed in accordance with the SSC Cultural Resources Management Plan and in consultation with the Mississippi SHPO. An MOA would be developed and implemented for such actions, as appropriate. Potential mitigation activities are discussed in Chapter 5 of this Final PEIS.

The construction of the A-3 Test Stand at SSC has not altered the historical attributes of the existing A and B test stands or affected their status as National Historic Landmarks.

4.1.1.2.9 Hazardous Materials and Hazardous Wastes

SSC uses hazardous materials and generates solid and hazardous waste from its research and development operations, laboratories, instrument repair, and operations and maintenance functions. The primary activity that would result in the consumption of hazardous materials would be engine testing, which involves the use of LOX, LH, and pyrotechnic igniters. Some hazardous wastes would be generated during renovations of the engine test stands. This waste would be handled and disposed of in accordance with current SSC practices and prescribed laws and regulations.

The Constellation Program activities would likely generate similar hazardous wastes and volumes as current operations. Volumes of waste would be comparable to the current operations. Wastes would be from solvents, cleaning rags, and lead-based paint. SSC currently maintains several satellite accumulation areas and one 90-day accumulation point. Waste disposal would be performed in accordance with current SSC practice and prescribed laws and regulations.

4.1.1.2.10 Transportation

Traffic levels on major roads and highways outside SSC are not expected to increase based on the Proposed Action. Operation of the test stands would require delivery of LOX, LH and, for the A-3 Test Stand, isopropyl alcohol by truck to SSC. Delivery and storage of LH and LOX is currently part of normal operations to supply propellants for testing Space Shuttle Main Engines and RS-68 engines. Each J-2X engine test would require delivery of nine truckloads of isopropyl alcohol. This would not impact transportation corridors.

Transportation of Constellation Program components between contractor sites, SSC, and other NASA Centers would strictly adhere to all DOT and Coast Guard regulations and could use rail, airplane, flat-bed truck, water vessel, or a combination thereof. Transport of J-2X and RS-68B engines between manufacturing, testing, and assembly locations would be via NASA- owned barges and flat-bed trucks, transportation methods currently utilized by the Space Shuttle Program. Traffic within the Center would be expected to remain at levels currently experienced under the Space Shuttle Program.

4.1.1.2.11 Environmental Justice

The Proposed Action is not expected to produce any consequences related to Environmental Justice. Due to the size of the SSC Buffer Zone surrounding the Fee Area, the proposed engine testing and test stand construction activities at SSC would not be expected to generate pollutant emission levels or noise levels that would result in offsite adverse effects on human health and the environment. Thus, the implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the vicinity of SSC.

NASA would continue to consider environmental justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy (see Section 4.1.1.1.11). Any disproportionately high or adverse human health or environmental effects of the

Constellation Program at SSC on low-income or minority populations would be identified and action would be taken to resolve public concern.

4.1.1.3 Michoud Assembly Facility

Table 4-11 summarizes the major activities currently anticipated at Michoud Assembly Facility (MAF) in support of the Constellation Program. At MAF, these reasonably foreseeable activities would be similar to ongoing activities conducted in support of the Space Shuttle Program. For the Constellation Program, MAF would manufacture, assemble, and test components of the Orion Crew Module and Service Module and the Ares I Upper Stage. In addition, MAF could possibly manufacture and assemble the Ares V Core Stage and/or Earth Departure Stage.

Table 4-11. Description of Constellation Program Work at MAF

Constellation Program Project	Project Responsibilities
Project Orion	Fabrication and assembly of structural components
Project Ares	Manufacture and assembly of the Ares I Upper Stage and possible manufacture and assembly of the Ares V Core Stage and/or Earth Departure Stage

While final decisions on where these activities would take place have not been made, the environmental impacts of manufacturing these components are addressed here to ensure they are captured in the overall analyses of this Final PEIS. Should these activities ultimately be accomplished elsewhere, they would be the subject of separate review and NEPA documentation, as appropriate.

The predicted environmental impacts of implementing the Constellation Program at MAF are similar to the environmental impacts of the ongoing Space Shuttle Program, which have been documented in various environmental documents, including the MAF Environmental Resources Document (MAF 2006b).

Several of the facilities at MAF identified for potential use in the Constellation Program may require modification. Many of the modifications would be modest such as internal upgrades to electrical wiring and moving interior walls. Table 2-10 summarizes the facility modifications being considered at this time to support the Constellation Program where the modifications might impact historic facilities or have the potential for environmental impacts sufficient to require additional analysis under an EA or an EIS. See Section 4.1.1.3.8 for discussion of historic/cultural impacts associated with facility modifications.

4.1.1.3.1 Land Resources

Activities described under the Proposed Action would not conflict with current land use plans at MAF. There are no coastal areas at MAF; however, there is a critical habitat within MAF's boundaries (see Section 3.1.3.6 for details). The Proposed Action would utilize legacy Space Shuttle Program facilities; therefore, there would be no potential impact on the listed critical habitat.

4.1.1.3.2 Air Resources

Currently, MAF is involved in the manufacture of the Space Shuttle External Tank and has historically produced about four tanks per year on average for the Space Shuttle Program. The Ares V Core Stage would use a modified version of the Space Shuttle External Tank. Given the planned launch manifest for the Ares V through 2020, it is not anticipated that MAF, if involved in the manufacture of the Ares V Core Stage, would require any major facility modifications to meet production demands for the Constellation Program.

Assembly of the Space Shuttle External Tanks includes activities that generate emissions. The LOX tank, LH tank, and intertank are welded, cleaned, have corrosion inhibitors and primer paints applied, and are coated with thermal protection systems (insulating foam and insulating ablators). Each of these processes results in air emissions of criteria and hazardous air pollutants. MAF also would be involved in fabricating the Orion Crew and Service Module structures which could result in air emissions similar to those resulting from fabrication of the External Tanks.

Because the types of manufacturing and manufacturing processes with implementation of the Constellation Program at MAF would not be expected to change substantially, the types and magnitude of hazardous air pollutants would be similar and would not measurably affect regional air quality associated with hazardous air pollutants.

Although the dimensions of the Space Shuttle External Tank would be different than the Ares V Core Stage, External Tank experience can be used to characterize the types and magnitude of Ares V toxic emissions as the manufacturing processes would be expected to be similar. In the 2003 Toxics Release Inventory, MAF reported 2,800 kg (6,200 lb) of methyl-ethyl-ketone (MEK) air releases and 1 kg (2 lb) of diisocyanate releases. The total reported emissions for the Orleans Parish in the 2003 Toxics Release Inventory exceeded 74,000 kg (162,000 lb), with the two largest emitters located within 3.2 km (2 mi) of MAF.

The 2002 National Emissions Inventory shows that the two large emitters located nearby to MAF released 962 mt (1,060 tons) of NO_x, 10 mt (11 tons) of SO_2, 101 mt (111 tons) of volatile organic compounds (VOCs), and 116 mt (128 tons) of CO. The total criteria pollutant emissions for Orleans Parish in 2002 were greater than 4,536 mt (5,000 tons) of particulate matter (PM_{10}); 4,536 mt (5,000 tons) of SO_2; 43,546 mt (48,000 tons) of NO_x; 97,978 mt (108,000 tons) of CO; and 19,051 mt (21,000 tons) of VOCs. Thus, the toxic air emissions from MAF are a very small fraction of the toxics released in the region. Similarly, the permitted emissions expected from the Constellation Program are very small.

Ozone depleting substances (ODS) used at MAF are associated with foam production activities for the Space Shuttle External Tank. Since 1990, NASA has reduced overall (nationwide) annual ODS usage from approximately 1.6 million kg (3.5 million lbs) down to less than 69,000 kg (150,000 lbs), a reduction of more than 96 percent. NASA is committed to finding safe and acceptable substitutes for remaining ODS uses.

The Upper Stage of the Ares I requires cryogenic insulation, or “cryoinsulation” as part of its Thermal Protection System to maintain the quality of the cryogenic propellants. It is possible that similar requirements may be identified for other Ares I and Ares V launch vehicle components as development progresses. Many Upper Stage performance requirements are expected to be similar to those of the Space Shuttle's External Tank, which uses cryoinsulation foams blown with HCFC 141b, a Class II ODS.

To comply with EPA requirements to phase out ODS, and to reduce the long-term supportability risk posed by ODS usage, NASA intends to develop cryoinsulation replacements for the Ares I Upper Stage that do not contain HCFC 141b or other phased out ODS. Building on and drawing from work done in support of the Space Shuttle Program, NASA has begun planning a research and development program to identify and qualify substitute cryoinsulation materials that meet Ares I Thermal Protection System technical requirements and fulfill the non-ODS objective. This test program would require relatively small amounts of HCFC 141b-blown foam for use in comparative studies. These studies are required to ensure that replacement cryoinsulation materials have similar properties and perform at least as well as the current materials in the challenging environments of launch, ascent, and atmospheric entry. The performance profile of the current Space Shuttle Program foams has been designated as the "performance baseline" for materials developed under these renewed research efforts. Successful implementation and operational performance of these materials will enable the Ares I and other space vehicle programs to use non-ozone depleting cryoinsulation.

Effects associated with global climate change and depletion of stratospheric ozone are discussed in Section 4.1.6.

4.1.1.3.3 Water Resources

Currently, it is not anticipated that the level or nature of Constellation Program activities at MAF would substantially differ from those that have been experienced under the Space Shuttle Program. Thus, Constellation Program activities would not adversely impact surface water or groundwater resources at MAF. The manufacture and assembly of the Ares I Upper Stage and the possible manufacture and assembly of the Ares V Core Stage and/or Earth Departure Stage at MAF would not be expected to exceed the Space Shuttle External Tank production levels and it is unlikely that there would be substantial additions to the MAF workforce. Thus, the capacity of the existing potable water and sanitary systems should not be exceeded. There would be no adverse impacts to floodplains at MAF due to Constellation Program activities.

4.1.1.3.4 Noise

None of the activities anticipated under the Proposed Action at MAF would be expected to result in excessive or unusual noise. Typical sources of noise at MAF include traffic and cooling towers. During peak traffic hours, noise levels are estimated to be between 70 and 74 dBA at 30 m (94.4 ft). Cooling towers are estimated to have noise levels of between 85 and 100 dBA at 1 m (3.3 ft), and between 61 and 83 dBA at 15 m (49.2 ft) (MAF 2006b).

4.1.1.3.5 Geology and Soils

Due to past activities, the soils and geology at MAF can be described as previously disturbed. Portions of the soil at MAF are currently contaminated due to past spills and disposal methods

(See Section 3.1.3.5 for more details). Since there are no construction projects at MAF associated with the Proposed Action, there would be no impacts to current conditions.

4.1.1.3.6 Biological Resources

Although some facility modifications would be required at MAF, no substantial adverse impacts on terrestrial or aquatic biota or habitat are anticipated. No adverse impacts to Federal or state-listed threatened or endangered species, critical habitat, or wetlands habitat are anticipated.

4.1.1.3.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

4.1.1.3.8 Cultural Resources

Table 4-12 lists the historic facilities on MAF that may be used by the Constellation Program. It is expected that upgrades and internal modifications to several historic facilities would occur at MAF. While most of these modifications would be minor and have little or no effect on the use or status of the properties, some could possibly be major and constitute an adverse effect as defined in 36 CFR 800.5, *Protection of Historic Properties* (MAF 2006b).

Table 4-12. Proposed MAF Historic Facilities Supporting the Constellation Program

Government Facility	Proposed Use of Facility	Proposed Modifications to the Facility	Historic Status	Anticipated Adverse Effects to Historic Properties
Vertical Assembly Facility (Building 110)	Ares I Upper Stage and Orion Crew Module, Service Module, back shell, and heat shield fabrication	Interior modifications	NRE	Possible
Acceptance and Preparation Building (Building 420)	Ares I Upper Stage	Major modifications, new floors, doors, tool sets, reconfiguration of the test control room	NRE	Possible
Pneumatic Test Facility and Control Building (Building 451 and Building 452)	Pressure and dynamic testing	Tooling structure and internal control modifications	NRE	Possible
High Bay Addition (Building 114)	Ares I Upper Stage and Ares V Core Stage assembly and foam application	Potential internal modifications	NRE	Possible

NRE = National Register Eligible (asset is eligible for listing on the National Register of Historic Places [NRHP])

Potential adverse effects to these or any other eligible resources would be mitigated in consultation with the Louisiana SHPO in accordance with Section 106 of the National Historic Preservation Act (NHPA). An MOA would be developed and implemented for these actions, as appropriate. Potential mitigation activities are discussed in Chapter 5 of this Final PEIS.

4.1.1.3.9 Hazardous Materials and Hazardous Wastes

Activities undertaken at MAF in support of the Constellation Program would be within the scope of normal activities at MAF. Many processes at MAF utilize hazardous materials and generate hazardous wastes in the production of External Tanks under the Space Shuttle Program. The tanks are welded, cleaned, have corrosion inhibitors and primer paints applied, and are coated with thermal protection systems (insulating foam and insulating ablators). Similar activities and similar waste streams would be expected for the Constellation Program. These would be handled in accordance with current MAF practices and prescribed laws and regulations and the MAF plan for managing hazardous materials and waste.

4.1.1.3.10 Transportation

Traffic levels on major roads and highways outside of MAF would not be expected to increase under the Proposed Action and would be expected to remain at levels currently experienced under the Space Shuttle Program. Currently, MAF uses the Mississippi River Gulf Outlet Canal to transport the Space Shuttle External Tank via barge to KSC. MAF has a Coastal Management Plan Permit to cover barge activities. MAF could use the Mississippi River Gulf Outlet Canal to transport Constellation Program components from MAF to either MSFC for testing or KSC for missions. Use of NASA's Super Guppy Aircraft would serve as backup to barge transport. Both barge and air transport would follow existing DOT transportation regulations.

In May 2007, the U.S. Army Corps of Engineers issued a draft report for public comment recommending that the Mississippi River Gulf Outlet Canal be closed. The final report will be a part of the Louisiana Coastal Protection and Restoration Report, and is due to Congress in December 2007. Congress would then consider legislation to authorize and fund the closure.

If the Mississippi River Gulf Outlet Canal is closed, a different route would need to be established for delivery of spacecraft components from MAF.

4.1.1.3.11 Environmental Justice

The Proposed Action is not expected to produce any consequences related to Environmental Justice. The proposed building modifications and operation activities at MAF would not be expected to result in adverse effects on human health and the environment. Thus, the implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the vicinity of MAF.

NASA would continue to consider environmental justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy (see Section 4.1.1.1.11). Any disproportionately high or adverse human health or environmental effects of the

Constellation Program at MAF on minority or low-income populations would be identified and action would be taken to resolve public concern.

4.1.1.4 Lyndon B. Johnson Space Center

Table 4-13 summarizes the major activities currently anticipated at the Lyndon B. Johnson Space Center (JSC) in support of the Constellation Program. Most of these reasonably foreseeable activities that would occur at JSC, including Ellington Field and Sonny Carter Training Facility, would be similar to ongoing activities conducted in support of the Space Shuttle Program and the International Space Station. As such, the environmental impacts of implementing the Constellation Program at JSC would be expected to be similar to the environmental impacts of the ongoing Space Shuttle Program and the International Space Station. These impacts have been documented in various environmental documents, including the JSC Environmental Resources Document (JSC 2004).

Table 4-13. Description of Constellation Program Work at JSC

Constellation Program Project	Project Responsibilities
Project Orion	Manage: • Overall Project Orion • Orion flight test program • Crew Module and vehicle integration, contractor oversight, and independent analysis, test, and verification • Flight test execution
Project Ares	Project Ares oversight Develop: • First stage recovery system • Upper Stage Reaction Control System • Abort certification Support: • Separation certification • Ares I reliability and safety assessments • Ares I mission operations planning • Avionics simulation development
Ground Ops Project	Oversee Ground Operations activities
Mission Ops Project	Mission Operations project management Development of capabilities and planning for mission operations, crew and flight controller training, and the Mission Control Center Coordinate crew operations during missions
Lunar Lander Project	Manage Lunar Lander Project
Extravehicular Activities Systems Project	Manage Extravehicular Activities Systems Project

Note: JSC provides overall Constellation Program Management, including Range Safety.

Several of the facilities at JSC identified for potential use in the Constellation Program may require modification. Many of the modifications would be minor such as internal upgrades to electrical wiring and moving interior walls. Table 2-10 summarizes new facility construction and modifications being considered to support the Constellation Program where the modifications might impact historic facilities or have the potential for environmental impacts sufficient to require additional analysis under an EA or an EIS. See Section 4.1.1.4.8 for discussion of historic/cultural impacts associated with the construction activities.

4.1.1.4.1 Land Resources

There would be no major disturbances of land contained within JSC as a result of the Proposed Action. The Constellation Program would primarily use legacy Space Shuttle Program and current International Space Station planning, training, and support facilities.

4.1.1.4.2 Air Resources

None of the activities anticipated under the Proposed Action at JSC would be expected to result in excessive or unusual air emissions.

Emissions generated as a result of the Proposed Action at JSC would likely be comparable to those associated with ongoing activities at the site. In addition to the minor occasional emissions generated at various research and test facilities, the largest potential source of emissions as a result of the Proposed Action would likely be vehicular (traffic) emissions. Any long-term incremental changes in vehicular emissions due to the Proposed Action would be proportional to the size of the workforce and are not known at this time. NASA would coordinate with state and local air quality planning agencies to ensure that any increased emissions conform to the State Implementation Plan for attainment with the ozone NAAQS.

4.1.1.4.3 Water Resources

Constellation Program activities would not adversely impact surface water or groundwater resources at JSC. No floodplains would be adversely impacted.

Most Constellation Program activities at JSC would take place in existing facilities and would not be expected to result in increased wastewater generation from those facilities. Wastewaters from existing Center facilities that either meet or are treated to meet Texas Natural Resource Conservation Commission pollutant limits are discharged to the Clear Lake City Water Authority treatment facility as noted in Section 3.1.4.3. Some wastewaters are disposed of separately (*e.g.*, photographic chemical wastewater from the Photographic Technology Laboratory).

4.1.1.4.4 Noise

None of the activities anticipated under the Proposed Action at JSC would be expected to result in excessive or unusual noise.

4.1.1.4.5 Geology and Soils

Due to the amount of NASA activity at JSC over the past 50 years, the land can accurately be described as previously disturbed soil. There is also possible contamination from a Freon® 113 plume (see Section 3.1.4.3 for more details). The Proposed Action would not result in increased Freon® 113 contamination. There would be no destruction of native and pristine geology/soil conditions.

4.1.1.4.6 Biological Resources

Constellation Program activities would not adversely impact biological resources at JSC. Most Constellation Program activities would take place in existing facilities. No Federal or state-protected species or habitat nor wetlands would be adversely impacted.

4.1.1.4.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

4.1.1.4.8 Cultural Resources

Table 4-14 lists the historic facilities on JSC that may be used by the Constellation Program. Mission operations that would be needed to support Constellation Program would be conducted in Building 30, but would not involve or pose an adverse effect on the Apollo Control Room, which is a National Historic Landmark or the Mission Control Center, which is eligible for listing in the NRHP. Anticipated modifications to Building 30 would be limited to rewiring or other minor modifications that would not affect the historic status of either property.

Any Constellation Program activities that may have an adverse effect on these or other historic resources would be managed in accordance with the JSC Cultural Resources Management Plan and in consultation with the Texas SHPO. An MOA would be developed and implemented for such actions, as appropriate. Potential mitigation activities are discussed in Chapter 5 of this Final PEIS.

There are no known archeological resources at JSC associated with Constellation Program activities; therefore, no impacts to archeological resources are anticipated.

4.1.1.4.9 Hazardous Materials and Hazardous Wastes

JSC currently uses hazardous materials for various research and development activities and generates hazardous wastes. Similar activities and similar waste streams could be expected for the Constellation Program. These would be handled in accordance with current JSC practices and prescribed laws and regulations and the JSC plan for managing hazardous materials and waste.

Table 4-14. Proposed JSC Historic Facilities Supporting the Constellation Program

Government Facility	Proposed Use of Facility	Proposed Modifications to the Facility	Historic Status	Anticipated Adverse Effects to Historic Properties
Crew Systems Laboratory, 3rd Floor (Building 7A)	Component and small unit bench top testing	None currently identified	NRE	Possible
Crew Systems Laboratory, 8- ft Chamber (Building 7)	Uncrewed integrated EVA life support system operational vacuum testing	None currently identified	NRE	Possible
Crew Systems Laboratory, 11- ft Chamber (Building 7)	Crewed EVA system vacuum testing	None currently identified	NRE	Possible
Crew Systems Laboratory, Thermal Vacuum Glovebox (Building 7)	Thermal vacuum testing of gloves and small tools	None currently identified	NRE	None
Communications and Tracking Development Laboratory (Building 44)	Orion test and verification	None currently identified	NRE	Possible
Mission Control Center (Building 30)	Mission control activities, astronaut – ground personnel interface	Internal modifications, computer and communications systems upgrades	NRE and contains Apollo Control Room NHL	Possible
Jake Garn Simulator and Training Facility (Building 5)	Astronaut training	Construct new Constellation Training Facility within existing Building 5 complex	NRE	Possible
Systems Integration Facility (Building 9)	Astronaut training	New facility within existing structure	NRE	Possible
Sonny Carter Training Facility (Building 920)	Astronaut training	None currently identified	NRE (Neutral Buoyancy Lab only [Building 920N])	None
Space Environment Simulation Laboratory – Chamber A (Building 32)	Crewed thermal vacuum testing and altitude chambers	None currently defined for thermal vacuum testing and no modifications to the altitude chamber	NHL	Possible

NRE = National Register Eligible (asset is eligible for listing on the National Register of Historic Places)
NHL = National Historic Landmark

4.1.1.4.10 Transportation

Traffic levels on major roads and highways outside JSC are not expected to increase based on the Proposed Action. Transportation of Constellation Program components between contractor sites, JSC, and other NASA Centers would strictly adhere to DOT regulations and could use rail, airplane, flat-bed truck, or a combination thereof. Traffic within the Center is expected to remain at levels currently experienced under the Space Shuttle and International Space Station Programs.

4.1.1.4.11 Environmental Justice

The Proposed Action is not expected to produce any consequences related to Environmental Justice. The proposed building modifications and operation activities at JSC would not be expected to result in adverse effects on human health and the environment. Thus, the implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the vicinity of JSC.

NASA would continue to consider environmental justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy (see Section 4.1.1.1.11). Any disproportionately high or adverse human health or environmental effects of the Constellation Program at JSC on minority or low-income populations would be identified and action would be taken to resolve public concern.

4.1.1.5 George C. Marshall Space Flight Center

Table 4-15 summarizes the major activities currently anticipated at MSFC in support of the Constellation Program. At MSFC, most of these reasonably foreseeable activities would be similar to ongoing activities conducted in support of ongoing programs and projects. As such, environmental impacts of implementing of the Constellation Program at MSFC would be expected to be similar to the environmental impacts from ongoing programs and projects, which have been documented in various environmental documents, including the MSFC Environmental Resources Document (MSFC 2002a).

Table 4-15. Description of Constellation Program Work at MSFC

Constellation Program Project	Project Responsibilities
Project Orion	Launch Abort System prime contractor oversight and independent analysis Service Module prime contractor oversight and independent analysis Abort Test Booster requirements development and validation
Project Ares	Manage Project Ares Upper Stage design, development, testing, and evaluation First Stage design Upper Stage and Earth Departure Stage development Upper Stage and Earth Departure Stage Main Propulsion Test Article engine testing Ares I and Ares V Ground Vibration Testing Ares V Core Stage design, development, testing, and evaluation Ares V SRB design and development RS-68B engine development

Several of the facilities at MSFC identified for potential use in the Constellation Program may require modification. Many of the modifications are relatively minor such as internal upgrades to electrical wiring and moving interior walls. However, some are more extensive. Table 2-10 summarizes new facility construction and modifications being considered to support the Constellation Program where the modifications might impact historic facilities or have the potential for environmental impacts sufficient to require additional analysis under an EA or an

EIS. See Section 4.1.1.5.8 for discussion of historic/cultural impacts associated with the construction activities.

Although Table 2-10 indicates the current plans for new facility construction or major rehabilitation of existing facilities associated with Constellation Program activities at MSFC, over the longer term, additional modifications would be reasonably expected. Should such requirements develop at MSFC during the course of implementing Constellation Program activities, these activities would be subject to separate NEPA review and documentation, as appropriate.

4.1.1.5.1 Land Resources

Activities described under the Proposed Action would not conflict with current land use plans at MSFC. Wheeler National Wildlife Refuge is located in close proximity to MSFC, an area with a high concentration of waterfowl. There are also multiple wetland areas within the Center's boundaries. None of these habitats would be impacted by the Proposed Action. There are no coastal areas or essential fish habitats within the Center's boundaries.

4.1.1.5.2 Air Resources

Under the Proposed Action, no new emission source categories would be added at MSFC. The air emissions from activities addressed in the Proposed Action are consistent with those listed in MSFC's CAA Title V Air Operating Permit (2005).

A new spray-on foam insulation spray booth would be constructed in one or more existing buildings at MSFC to support the development of the Ares I Upper Stage Thermal Protection System. This activity would potentially require modification to the existing CAA Title V air permit.

Emissions from a range of potential engine testing activities at MSFC were modeled in the *Engine Technology Support EIS* (MSFC 1997a). Detailed emissions projections for the range of engine types, including engines more powerful than those anticipated for the Constellation Program, are reported in that EIS. Ongoing and proposed Constellation Program-related engine testing at MSFC would fall in the small- and medium-size thrust categories that were evaluated in the *Engine Technology Support EIS* (MSFC 1997a).

Plans for engine testing at MSFC are consistent with the February 28, 1998 ROD for the *Engine Technology Support EIS* (MSFC 1998). That ROD concluded that:

> *SSC will be used for all multiple engine testing whose collective thrust level exceeds that of one large engine. Small, medium, and large single engine testing may be conducted at either SSC or MSFC, depending on schedule and other programmatic needs established by SSC in its role as NASA's lead Center for propulsion testing.*

Thus, the emissions generated at MSFC as a result of the Proposed Action would be consistent with the existing permitted sources.

4.1.1.5.3 Water Resources

Constellation Program activities at MSFC would not be expected to adversely impact surface water or groundwater resources. Wastewater discharges at MSFC are released to Indian Creek, Huntsville Spring Creek, and Wheeler Lake via 21 outfall points in accordance with an NPDES permit (MSFC 2002a). Ares Upper Stage engine testing at the Advanced Engine Test Facility (Building 4670) in the West Test Area would not require modification of the existing NPDES permit. Cooling water for engine testing would be supplied by Redstone Arsenal, and would be discharged into a 4-ha (11-ac) detention pond, which flows into Indian Creek under an NPDES permit. While small quantities of waste solvents, oils and lubricants, and dust particles may be washed into the cooling water discharge, it is not anticipated that NPDES permit requirements would be exceeded.

The water supply system from Redstone Arsenal is capable of providing 34×10^6 l per day (9 million gallons per day [mgd]) of potable water and 130×10^6 l per day (34 mgd) of industrial water. MSFC's 2001 demand of 3.8×10^6 l per day (0.85 mgd) potable water and 6.6×10^6 l per day (1.74 mgd) of industrial water was well within the facility's capabilities (MSFC 2002a). Constellation Program activities would not be expected to increase demand above these levels.

4.1.1.5.4 Noise

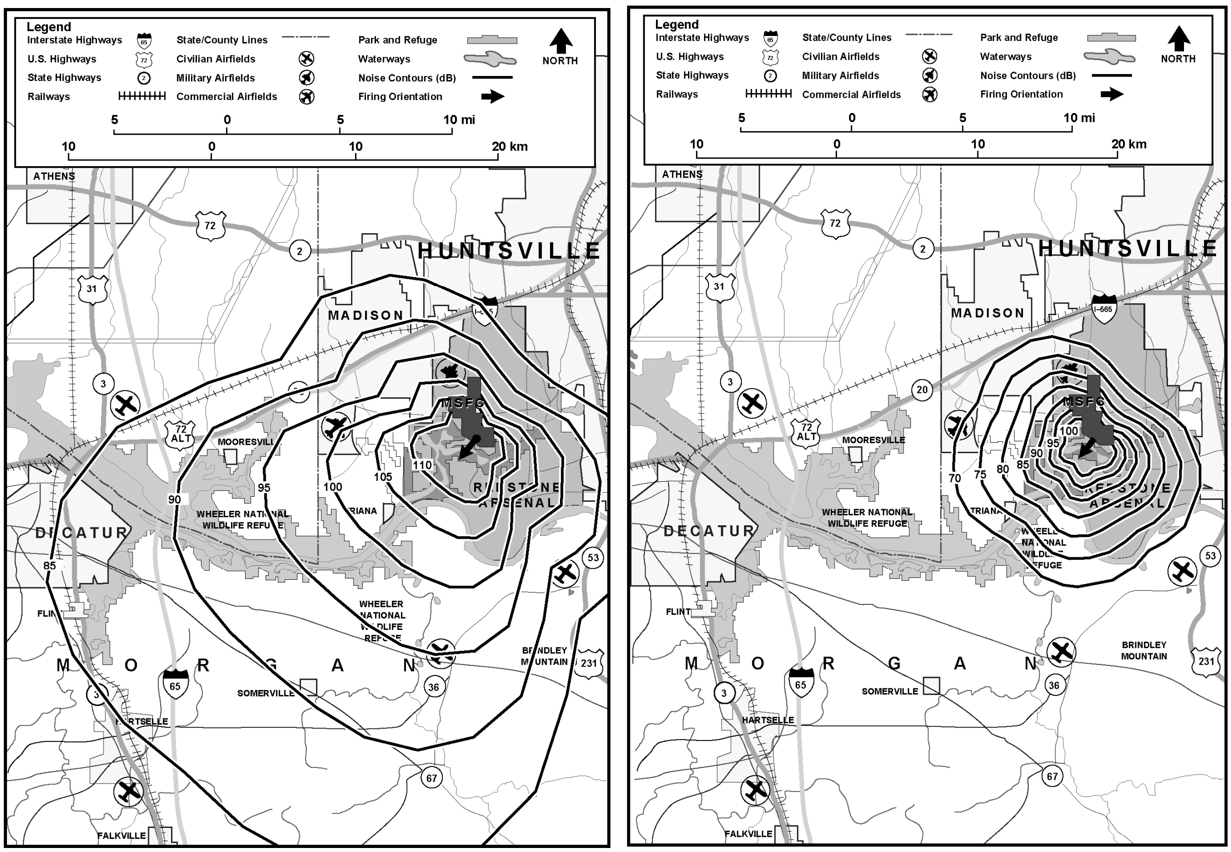
None of the activities identified in the Proposed Action would generate a major, new type of noise source at MSFC. Minor increases in noise could be experienced during construction activities. MSFC would have major responsibilities in the development of the J-2X Upper Stage engine and would perform full-scale J-2X engine testing (Main Propulsion Test Article) and engine component testing. Rocket engine testing is consistent with ongoing development and testing activities at MSFC. All engine test facilities are located in the southern portion of MSFC approximately 4 to 12 km (2.5 to 7 mi) from the nearest private property. Ground vibration testing of the Ares I launch stack and possibly the Ares V launch stack also would be performed at MSFC.

The Main Propulsion Test Article testing would occur in the Advanced Engine Test Facility, in the West Test Area. This engine test would produce approximately 9.3×10^5 N (210,000 lbf) of thrust (in vacuum) using LOX/LH and produce primarily water vapor as exhaust. The thrust of this engine is somewhat smaller than the thrust of the Space Shuttle Main Engine that was tested at MSFC. The 100% power thrust of the Space Shuttle Main Engine is 1.67×10^6 N (375,000 lbf) at sea level and 2.09×10^6 N (470,000 lbf) in a vacuum.

The noise impacts of engine testing were extensively evaluated in the *Engine Technology Support EIS* (MSFC 1997a). The *Engine Technology Support EIS* was reviewed in May 2007 in relation to proposed Constellation Program engine testing activities. That EIS evaluated the noise impacts of liquid rocket engine testing for large (12×10^6 N [2.6 million lbf]) thrust, medium (3.6×10^6 N [816,000 lbf]) thrust, and small (1.7×10^6 N [386,000 lbf]) thrust engines at MSFC. Although the actual noise produced by a rocket engine is a function of several engine parameters, including thrust, specific impulse, exhaust velocity, throttle exit diameter, acoustic efficiency, and mechanical power, the noise generated generally scales with overall engine thrust.

Modeling reported in the *Engine Technology Support EIS* indicated that for the range of engine sizes evaluated, the maximum sound pressure at the closest private property to MSFC test sites would be 107 to 119 dB. This corresponds approximately to A-weighted sound levels of 97 dBA, 96 dBA, and 94 dBA for the large, medium, and small-thrust engines, respectively, modeled in that EIS (MSFC 1997a). Constellation Program engine testing at MSFC would fall in the small and medium size categories.

Figure 4-9 presents the sound level predictions for a small-thrust engine, which bounds the J-2X engine (the noise from a single 9.3×10^5 N [210,000 lbf] thrust J-2X engine test would be bounded by the noise generated by the 1.7×10^6 N [386,000 lbf] small-thrust engine as evaluated in the *Engine Technology Support EIS* [MSFC 1997a]). The sound pressure contours are presented on the left side and the A-weighted sound pressure contours are presented on the right side of Figure 4-9.



Source: MSFC 1997a

Figure 4-9. Sound Level Predictions (dB) [left] and A-Weighted Sound Level Predictions (dBA) [right] for Testing One Small-Thrust Engine at MSFC

The A-weighted noise contours in Figure 4-9 show the extent of middle- and high-frequency noise that humans can hear. These contours cover a much smaller area than the sound pressure (OASPL) contours because of the low content of middle- and high-frequency sounds produced by rocket engines. The A-weighted process attenuates the overall sound pressure spectrum to match the frequency response of the human auditory system. The predicted maximum offsite

A-weighted sound levels would be approximately 94 dBA. These noise levels would be very noticeable but would represent an insignificant noise impact because of the short duration (190 second maximum full duration test). People are exposed to similar noise levels from traffic, aircraft, and other normal daily activities.

The *Engine Technology Support EIS* modeling indicated that while rocket test noise would be readily apparent offsite, it would not cause significant damage to structures or impacts to the public. This is consistent with what has been historically observed in the nearby communities. Natural obstructions (trees) and short test durations would lower the risk of structural damage. The likelihood of structural damage from the small-thrust engine tests (as indicated by damage claims from the public) is less than 1 in 1,000, resulting in insignificant impacts to the community (MSFC 1997a).

The MPTA testing would produce noise levels lower than those modeled in the *Engine Technology Support EIS* for small-thrust engines but the duration of the tests would be up to seven minutes, substantially longer than the 190-second tests considered in the *Engine Technology Support EIS*. At the projected sound pressure levels, the longer duration tests would increase the nuisance potential of the tests for nearby residents and the potential disturbance of wildlife.

The maximum predicted offsite noise levels would be 94 dBA during Constellation Program engine testing. Offsite noise levels of 94 dBA for up to seven minutes would be lower than the 100 dBA two-hour exposure threshold at which OSHA requires a hearing conservation program (29 CFR 1910.95). The offsite noise levels would also be much lower than levels at which OSHA would require hearing protection or engineering controls for workers. OSHA requires hearing protection or engineering controls be applied if workers are exposed to sound levels greater than 115 dBA for more than a quarter of an hour (29 CFR 1926.52). Therefore, no hearing effects among the general public would be projected.

The impacts of noise from MSFC engine tests are mitigated by the physical separation of the test facilities from the general public. MSFC is surrounded by a large federally owned area consisting of the Redstone Arsenal and the Wheeler National Wildlife Refuge. These areas provide an effective noise barrier between MSFC activities and the general public.

Speech Interference—Speech interference can occur at ambient noise levels above approximately 70 dBA, where people engaged in conversation outdoors would have to speak louder or move closer together to continue the conversation. In some locations near MSFC, the noise level would be above 70 dBA during the brief Constellation Program engine tests and conversation would be momentarily interrupted. However, tests would be of short duration (J-2X test durations would be up to seven minutes), and would be infrequent. The impacts of speech disruptions would be minimal.

Sleep Interference—Interference with sleep can occur at noise levels as low as 35 dBA. Daytime testing activities would not interfere with nighttime sleeping patterns. People who sleep during the day must normally learn to sleep with a greater level of exterior noise. At noise levels of 94 dBA during Constellation Program engine tests, some interference with daytime sleepers would be expected. However, due to the infrequency of tests and their short duration (J2-X test durations up to seven minutes), the impact would be expected to be minimal.

Mitigation—In the ROD for the *Engine Technology Support EIS* (MSFC 1998), NASA committed to monitor meteorological conditions prior to testing at MSFC to reduce the potential impacts of acoustic focusing of the engine noise. NASA would continue to follow this practice for engine testing at MSFC during the Constellation Program. See Chapter 5 for more details.

Although MSFC has been used for space propulsion engine testing since its establishment in 1960, NASA anticipates that the testing of the full-scale, large rocket engines for the Constellation Program, including the RS-68B and clusters of five RS-68B engines, would occur at the SSC. Since full-scale, large rocket engine testing would occur at SSC, the noise generated at MSFC as a result of the Proposed Action would be limited to the typical types of engine testing, industrial and vehicular noise that are already present at the site.

4.1.1.5.5 Geology and Soils

Due to past activities, the geology and soil of MSFC can be described as previously disturbed. MSFC is listed in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (EPA 2006c) because it contains preexisting soil contamination. Proposed activities would be expected to have minimal impacts to the geology and soils at MSFC. Modifications to facilities located within MSFC CERCLA site would comply with access requirements contained in Marshall Procedural Requirements (MPR) 8500.1, *MSFC Environmental Management Program*.

4.1.1.5.6 Biological Resources

Constellation Program activities at MSFC would not be expected to adversely impact biological resources. Most Constellation Program activities would take place within existing structures; no new major facility construction is anticipated at MSFC. Engine testing at the Advanced Engine Test Facility in the West Test Area would be located within the boundary of Wheeler National Wildlife Refuge, approximately 1,000 feet from the Wheeler Lake wetlands. The 4-ha (11-acre) detention pond serving the Advanced Engine Test Facility is a non-jurisdictional wetland receiving NPDES-permitted engine test cooling water.

Engine tests would generate high levels of noise on an intermittent basis during a test campaign. This noise would be expected to elicit a startle response from some wildlife in nearby areas. However, engine test noise is temporary, with no long-term adverse impacts on resident species (MSFC 2002a).

Constellation Program activities would not be expected to adversely impact Federal protected species or habitat, or state-ranked species at MSFC. The Alabama cave shrimp (*Palaemonias alabamae*) (Federal endangered) inhabits cave water pools and possibly subterranean caverns in bedrock. No caves with surface entrances are known to exist in the Advanced Engine Test Facility area. The Tuscumbia darter's (*Etheostoma tuscumbia*) (state protected) only known habitat is more than a mile northwest and upstream of the West Test Area and the Advanced Engine Test Facility. A site survey has been conducted which did not reveal any protected species onsite (MSFC 2002b).

4.1.1.5.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

4.1.1.5.8 Cultural Resources

Table 4-16 lists the historic facilities on MSFC that may be used by the Constellation Program. NASA is proposing major modifications to the Structural Dynamic Test Facility (Building 4550) to support Ares I ground vibration testing. The modifications would include updates to and refurbishment of electrical (*e.g.*, power, lighting, and communications), mechanical (*e.g.*, plumbing, fire protection, utilities, and special gas supplies) and architectural (*e.g.*, control rooms, security enhancements, and storage rooms) in support of the structural dynamic test activities. This facility was used for dynamic testing of both Saturn V and Space Shuttle launch vehicles. This action is addressed in the *Final Environmental Assessment for Modification and Operation of TS 4550 in Support of Ground Vibration Testing for the Constellation Program*.

Table 4-16. Proposed MSFC Historic Facilities Supporting the Constellation Program

Government Facility	Proposed Use of Facility	Proposed Modifications to the Facility	Historic Status	Anticipated Adverse Effects to Historic Properties
Hardware Simulation Laboratory (Building 4436)	Ares Upper Stage engine control system and software testing and avionics and systems integration	Minor upgrades. May need to add air conditioning, walls, and power	NRE	Possible
Avionics Systems Testbed (Building 4476)	Ares Upper Stage avionics integration	Minor upgrades	NRE	None
Test Facility 116 (Building 4540)	Ares Upper Stage component testing. Subscale injector tests, RD-68 gas generator igniter tests, Main Injector Igniter Test Program	Modify test equipment to accommodate test requirements and component interfaces.	NRE	Possible
Structural Dynamic Test Facility (Building 4550)	Ares I and Ares V Ground Vibration Testing	See note at end of table. Major modifications	NHL	Possible
Hot Gas Test Facility (Building 4554)	Ares I First Stage design configuration certification and Upper Stage hot gas testing	Improvements/repairs, minor modifications, and test equipment modifications	NRE	Possible

Table 4-16. Proposed MSFC Historic Facilities Supporting the Constellation Program (Cont.)

Government Facility	Proposed Use of Facility	Proposed Modifications to the Facility	Historic Status	Anticipated Adverse Effects to Historic Properties
Propulsion and Structural Test Facility (Building 4572)	Testing Ares I First Stage and Ares Upper Stage pressure vessel components	Minor modifications	NHL	Possible
Test and Data Recording Facility (Building 4583)	Ares Upper Stage spark igniter testing, turbo-pump and combustion devices testing	Modify propellant supply lines and vacuum chamber	NRE	Possible
Materials and Processes Laboratory (Building 4612)	Materials testing	Minor upgrades to install equipment, plating facility may need minor modifications.	NRE	Possible
Structures and Mechanics Lab (Building 4619)	Ares Upper Stage engine vibration testing, structural testing, avionics thermal/vacuum testing, and heat treatment processing	Minor upgrades including installation of test equipment and reconfiguration of equipment	NRE	Possible
Huntsville Operations Support Center (HOSC/NDC) (Building 4663)	Engineering support for Ares Upper Stage development operations; data gathering, processing and archiving for engine and propulsion behavior analysis	Minor modifications	NRE	Possible
Advanced Engine Test Facility (Building 4670)	Ares Upper Stage engine testing	Major reactivation work, structural changes necessary	NRE	Possible
Multi-purpose High Bay and Neutral Buoyancy Simulator Complex (Building 4705)	Ares Upper Stage fabrication	Minor upgrades – new tooling, installation of equipment.	NHL	Possible
National Center for Advanced Manufacturing (Building 4707)	Ares Upper Stage support actions and evaluations	Substantial upgrades	NRE	Possible
Engineering and Development Laboratory (Building 4708)	Final assembly and preparation for Ares Upper Stage testing	Minor modifications	NRE	Possible
Wind Tunnel Facility (Building 4732)	Ares wind tunnel testing	None currently identified	NRE	None

NHL = National Historic Landmark
NRE = National Register Eligible (asset is eligible for listing on the National Register of Historic Places)

Note: The Final *Environmental Assessment for Modification and Operation of TS 4550 in Support of Ground Vibration Testing for the Constellation Program* has addressed this action.

Any Constellation Program activities that may have an adverse effect on these or other historic resources would be managed in accordance with the MSFC Cultural Resources Management Plan and in consultation with the Alabama SHPO. An MOA would be developed and implemented for such actions, as appropriate. Potential mitigation activities are discussed in Chapter 5 of this Final PEIS.

There are no known archeological resources at MSFC associated with Constellation Program activities; therefore, no impacts to archeological resources are anticipated.

4.1.1.5.9 Hazardous Materials and Hazardous Wastes

MSFC uses hazardous materials for various research, development, and flight hardware assembly and testing activities, which in turn generate hazardous wastes. The Proposed Action would not result in hazardous material use or hazardous waste generation significantly different than current activities.

4.1.1.5.10 Transportation

Traffic levels on major roads and highways outside MSFC are not expected to increase based on the Proposed Action. Transportation of Constellation Program components between contractor sites, MSFC, and other NASA Centers would strictly adhere to all DOT and Coast Guard regulations and could use rail, airplane, flat-bed truck, water vessel, or a combination thereof. ATK plans to transport the Ares I First Stage test articles to MSFC for structural dynamic testing via rail. The railhead at Redstone Arsenal would be structurally modified to accommodate the delivery and offloading of the test article at MSFC. The proposed modifications to the railhead would be subject to separate NEPA review and documentation, as appropriate (MSFC 2007h). A barge or flat-bed truck would be used to transport Ares test articles from MAF for structural dynamic testing at MSFC. Currently, these are the transportation methods utilized by the Space Shuttle Program. Traffic within the Center is expected to remain at levels currently experienced under the Space Shuttle Program.

4.1.1.5.11 Environmental Justice

The Proposed Action is not expected to produce any consequences related to Environmental Justice. Due to the size of the buffer zone between the general public and the engine test stand and the buildings to be modified, the proposed activities at MSFC would not be expected to generate noise levels that would result in offsite adverse effects on human health and the environment (MSFC 2007g). Additionally, air emissions would be within permitted levels. Thus, the implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the vicinity of MSFC.

NASA would continue to consider environmental justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy (see Section 4.1.1.1.11). Any disproportionately high or adverse human health or environmental effects of the Constellation Program at MSFC on minority or low-income populations would be identified and action would be taken to resolve public concern.

4.1.1.6 John H. Glenn Research Center (Lewis Field and Plum Brook Station)

Table 4-17 summarizes the major activities that would be supported by GRC for the Constellation Program. Most of these reasonably foreseeable activities at GRC would be similar to ongoing activities conducted in support of other NASA programs. As such, the environmental impacts of implementing the Constellation Program at GRC would be expected to be similar to the environmental impacts from the other ongoing programs, which have been documented in various environmental documents, including the GRC Environmental Resources Document (GRC 2005).

Table 4-17. Description of Constellation Program Work at GRC

Constellation Program Project	Project Responsibilities
Project Orion	Manage: • Integrated Orion qualification testing • Orion Service Module and spacecraft adapter development • Preliminary production module for the Service Module and Spacecraft Adapter Design and develop simulated Orion spacecraft for Ares I-X
Project Ares	Design and development of Ares I Upper Stage subsystems Upper Stage simulator for Ares I-X flight tests Possible site for Upper Stage J-2X engine testing
Extravehicular Activities Systems Project	Provide power, communications, informatics, and avionics support

At least two facilities at GRC identified for potential use in the Constellation Program may require modification. Most of the modifications would be relatively minor such as internal upgrades to electrical wiring and moving interior walls. However, some would be more extensive. Table 2-10 summarizes modifications being considered to support the Constellation Program where the changes might impact historic facilities or have the potential for environmental impacts sufficient to require additional analysis under an EA or an EIS. See Section 4.1.1.6.8 for discussion of historic/cultural impacts associated with the construction activities.

4.1.1.6.1 Land Resources

Activities described under the Proposed Action would not impact or conflict with current land use plans at Lewis Field or Plum Brook Station (PBS). There are no coastal areas or sensitive habitats that would be affected under the Proposed Action.

4.1.1.6.2 Air Resources

None of the activities anticipated under the Proposed Action at Lewis Field or PBS would be expected to result in excessive or unusual emissions.

Modifications to existing facilities could potentially generate air emissions during construction. Once operational, none of the modified facilities would be expected to generate excessive or unusual emissions.

Emissions generated as a result of the Proposed Action at Lewis Field and PBS would likely be much like the ongoing activities at those two sites. In addition to the minor occasional emissions generated at various research and test facilities at the two sites, the dominant source of emissions as a result of the Proposed Action would be vehicular (traffic) emissions. Any long-term incremental changes in vehicular emissions due to the Proposed Action would be proportional to the size of the workforce and are not known at this time.

Potential impacts at PBS would include air emissions from Ares J-2X engine testing in the Spacecraft Propulsion Research Facility (B-2 Facility) (Building 3211). These tests would be conducted in a large vacuum chamber. Exhaust products from the engine would include water vapor from the LOX/LH combustion which would be captured by the facility's exhaust system.

4.1.1.6.3 Water Resources

Constellation Program activities at Lewis Field would not be expected to adversely impact surface water or groundwater resources. No new construction or major facility rehabilitation is anticipated at Lewis Field. Wastewater generated by Constellation Program activities would be within the quantities currently generated at Lewis Field and would not necessitate modification of the existing discharge permits. Site stormwater discharges to the Rocky River are subject to two state NPDES permits. There is no evidence to date that these discharges have had an adverse environmental impact on the river. Discharges from limited printing, plating, and metal shop operations have largely been eliminated by process substitution, recycling, or containerization for offsite disposal. The Industrial Waste Sewer System receives primarily cooling water discharges and some wastewaters. Discharges from the Industrial Waste Sewer are first accumulated in detention basins prior to discharge to the sanitary sewer system. The sanitary sewer system flows to the Southerly Wastewater Treatment Plant of the Northeast Ohio Regional Sewer District for tertiary treatment. No impact on groundwater or floodplains would be anticipated as a result of Constellation Program activities.

Constellation Program activities at PBS would not adversely impact surface water or groundwater resources. Wastewater generated by Constellation Program activities at PBS would not necessitate modifications of the existing permits. Wastewater discharges include stormwater, noncontact cooling water, cooling tower and boiler blowdown, and sanitary discharges. There are currently no significant sources of process wastewater at PBS with the exception of test engine cooling water, which will be contained in a closed loop system discharging to lined settling ponds.

Constellation Program activities at Lewis Field or PBS would not be expected to adversely impact either potable water supplies or sanitary sewer services provided by the county.

4.1.1.6.4 Noise

None of the activities anticipated under the Proposed Action at Lewis Field or PBS would be expected to result in excessive or unusual noise. Construction activities during modifications to existing facilities could potentially be a minor noise source. Once operational, none of the modified facilities that would support the Constellation Program would be expected to generate excessive or unusual noise.

In addition to the occasional minor noise generated at various research and test facilities at the two sites, the dominant sources of noise resulting from the Proposed Action would be from vehicles (traffic) and cooling towers. Traffic noise would be approximately proportional to workforce levels for the Proposed Action. Because of the large size of the site and the background noise from the nearby airport and industrial activities at the Lewis Field site, any incremental noise associated with the Proposed Action would not directly affect the offsite population.

Additional noise generated as a result of the proposed engine testing at PBS would likely be similar to ongoing and past activities at the site. Operation of the mechanical equipment supporting the large vacuum chamber would generate noise near the building. The potential impacts associated with noise from Ares J-2X engine testing in the B-2 Facility would be minor. The tests would be conducted in a large vacuum chamber facility which is largely underground; thus, reducing the direct noise associated with the tests and the potential for impacts to people offsite and to wildlife.

4.1.1.6.5 Geology and Soils

Due to past activities, the soils and geology of Lewis Field can be described as previously disturbed. There have been multiple instances of soil contamination documented at the Center (see Section 3.1.6.5 for more details). Since there are no construction requirements under the Proposed Action, there would be no impacts to current conditions at Lewis Field.

Minor soil disturbances would occur at PBS during the construction and rehabilitation phases of renovation of the Spacecraft Propulsion Research Facility (B-2 Facility-Building 3211) and the Space Power Facility (Building 1411). Installation of a seismic floor in the Space Power Facility would require some excavation. All excavations would be assayed for potential soil contamination and managed according to existing PBS policies and procedures.

4.1.1.6.6 Biological Resources

Constellation Program activities at Lewis Field would not be expected to adversely impact biological resources at the site. Lewis Field is highly developed and supports typical urban wildlife. Only two known Ohio-listed potentially threatened species, pigeon grape (*Vitis cinerea*) and American chestnut (*Castanea dentata*), are located on Lewis Field. Neither species would be adversely impacted by Constellation Program activities. No activities proposed for Lewis Field are located within floodplains. Wetlands at the Lewis Field site have not been officially designated. A 2002 survey indicated four areas as probable wetlands. None of these areas would be adversely impacted by Constellation Program activities.

It is not anticipated that Constellation Program activities would adversely impact any of the federally or state protected species or special management areas on PBS. No PBS facilities are in the 100-year floodplain and no potential wetland areas are expected to be adversely impacted by Constellation Program activities.

4.1.1.6.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

4.1.1.6.8 Cultural Resource

Table 4-18 lists the historic facilities at Lewis Field and PBS that may be used by the Constellation Program. Testing of the J-2X engine at PBS would require modifications to the B-2 Vacuum Facility, which is part of the Spacecraft Propulsion Research Facility (Building 3211), a National Historic Landmark. The modifications would be considered an adverse effect and would therefore have to be managed in consultation with the Ohio SHPO and in compliance with Section 106 of the NHPA.

Table 4-18. Proposed GRC Historic Facilities Supporting the Constellation Program

Government Facility		Proposed Use of Facility	Proposed Modifications to the Facility	Historic Status	Anticipated Adverse Effects to Historic Properties
GRC-Lewis Field	Instrument Research Laboratory (Building 77)	Miniature sensor and associated validation software development for LH and LOX leak detection.	None currently identified	NRE	None
	10-ft by 10-ft Supersonic Wind Tunnel Office and Control Building (Building 86)	Integrated design analysis and independent verification and validation in support of Orion vehicle design	None currently identified	NRE	None
GRC-Plum Brook Station	Spacecraft Propulsion Research Facility (B-2 Facility) and associated buildings (Building 3211)	Alternate site option for Ares Upper Stage and/or Earth Departure Stage testing	If selected for testing, construction and/or modifications of test chamber, cold wall, cryogenic liquid and gas systems, spray chamber modifications, new boilers and ejector systems, and building refurbishment	NHL	Yes
	Space Power Facility (SPF) – Disassembly Area (Building 1411)	Orion acoustic/random vibration, thermal vacuum, and electromagnetic compatibility/interference testing	New seismic floor and shaker system and new acoustic chamber within disassembly highbay area.	NRE	None

NRE = National Register Eligible (asset is eligible for listing on the National Register of Historic Places)
NHL = National Historic Landmark

The Space Power Facility (Building 1411) at PBS is eligible for listing on the NRHP and would be used for Orion acoustic/random vibration, thermal vacuum, and electromagnetic compatibility/interference testing. Use for this purpose would require excavating the existing floor and installing a new concrete floor. If unknown or unevaluated cultural resources are located during excavation, NASA would comply with the draft GRC Cultural Resources Management Plan, Section 106 of the NHPA, and consult with the Ohio SHPO if required.

Any Constellation Program activities that may have an adverse effect on these or other historic resources would be reviewed by the GRC Historic Preservation Officer and conducted in consultation with the Ohio SHPO. An MOA would be developed and implemented for such actions, as appropriate. Potential mitigation activities are discussed in Chapter 5 of this Final PEIS.

No specific ground-disturbing activity at Lewis Field is associated with the Proposed Action. In addition, archeological investigations have demonstrated that although Lewis Field is located in an area that would ordinarily be considered sensitive for archeological resources, it is highly disturbed throughout its extent and significant resources are unlikely to be present (GRC 2005).

There are no known archeological resources at PBS associated with Constellation Program activities; therefore, no impacts to archeological resources are anticipated.

4.1.1.6.9 Hazardous Materials and Hazardous Wastes

Under the Proposed Action, GRC would undertake design, fabrication, assembly, test, and development activities which fall within the range of normal activities performed at GRC. The Proposed Action would not result in hazardous material use or hazardous waste generation significantly different from current activities.

4.1.1.6.10 Transportation

Traffic levels on major roads and highways outside Lewis Field are not expected to increase based on the Proposed Action. Any transportation of Constellation Program components between contractor sites, Lewis Field, and other NASA Centers would be accomplished using rail, airplane, flat-bed truck, or a combination thereof, and would strictly adhere to all DOT regulations. Traffic within Lewis Field is expected to remain at current levels.

Deliveries of cryogens to support engine testing at the B-2 Facility at PBS would be expected to increase; however, local traffic patterns would not be affected. Risk reduction measures, as necessary, would be coordinated with local and state law enforcement for the safe delivery of these fuels. Normal traffic routes onsite would be redirected as necessary to reduce risk while these deliveries are made. No new transportation issues would be expected related to the transportation of test articles to and from the Space Power and B-2 Facilities.

4.1.1.6.11 Environmental Justice

The Proposed Action is not expected to produce any consequences at Lewis Field or PBS related to Environmental Justice. The proposed building modifications at PBS and operation activities at both sites would not be expected to result in adverse effects on human health and the environment. Thus, the implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the Lewis Field and PBS vicinities.

NASA would continue to consider environmental justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy (see Section 4.1.1.1.11). Any disproportionately high or adverse human health or environmental effects of the Constellation Program at Lewis Field or PBS on minority or low-income populations would be identified and action would be taken to resolve public concern.

4.1.1.7 Langley Research Center

Table 4-19 summarizes the major activities currently anticipated at Langley Research Center (LaRC) in support of the Constellation Program. Most of these reasonably foreseeable activities would be similar to ongoing activities conducted in support of NASA programs.

Table 4-19. Description of Constellation Program Work at LaRC

Constellation Program Project	Project Responsibilities
Project Orion	Orion drop testing Manage: • Development and production of the Launch Abort System • Crew Module landing system development Produce: • Crew Module test articles for the first pad abort and first ascent abort flight tests • Separation Rings for all abort flight tests Support Thermal Protection System development
Project Ares	Aerodynamic characterization of integrated launch vehicle, aerodynamic database development, and aeroelasticity test and analysis Vehicle integration activities for Ascent Development Flight Test Support Upper Stage design, development, testing, and evaluation

There are several facilities at LaRC identified for potential use in the Constellation Program that may require modification. Most of the modifications would be relatively minor such as internal upgrades to test equipment and components. Table 2-10 summarizes modifications being considered in support of the Constellation Program where the modifications might impact historic facilities or have the potential for environmental impacts sufficient to require additional analysis under an EA or an EIS. See Section 4.1.1.7.8 for discussion of historic/cultural impacts associated with the construction activities.

4.1.1.7.1 Land Resources

Activities described under the Proposed Action would not conflict with current land use plans at LaRC. There are wetlands located near the Impact Dynamics Facility (Gantry) (Building 1297);

however, they would not be impacted by the Proposed Action. In addition, since the Proposed Action is within the Center's current scope of activity, no sensitive habitats would be impacted.

LaRC is located within the "coastal zone" as defined under the Virginia Department of Environmental Quality's Virginia Coastal Resources Management Program. Therefore, the proposed activities under the Constellation Program must be consistent with the Virginia Coastal Resources Management Program's enforceable policies regarding coastal resources. Given the location and nature of activities to be conducted at LaRC under the Proposed Action, the following enforceable policies would not be applicable: fisheries, subaqueous land, wetlands, dunes and beaches, and shoreline sanitation. Pollution control (point and non-point source) and air pollution would be in accordance with existing Virginia Department of Environmental Quality permits as further detailed in Sections 4.1.1.7.2 and 4.1.1.7.3, respectively. LaRC has determined that these activities can be implemented within the existing framework of environmental regulations and would be consistent with the enforceable programs and advisory policies of the Virginia Coastal Resources Management Program.

4.1.1.7.2 Air Resources

None of the activities anticipated under the Proposed Action at LaRC would be expected to result in excessive or unusual emissions.

Construction activities are limited and of the type to produce very few emissions. Painting of the Gantry would produce air emissions. Areas consisting of old paint that require repainting have been tested and were found to contain lead. Lead removal/abatement would be conducted in accordance with health, safety, and environmental laws and regulations. Other construction activities during facility modifications could potentially be minor emissions sources during construction. Once operational, none of the modified facilities would be expected to increase or generate unusual emissions.

Emissions generated as a result of the Proposed Action would likely be much like the ongoing activities at the site. In addition to the minor occasional emissions generated at various research and test facilities, the dominant source of additional emissions as a result of implementing the Proposed Action would be vehicular (traffic) emissions. Any long-term incremental changes in vehicular emissions due to the Proposed Action would be proportional to the size of the workforce and are not known at this time.

4.1.1.7.3 Water Resources

Constellation Program activities at LaRC would not be expected to adversely impact surface water or groundwater resources. Most actions would be conducted inside existing buildings in accordance with the current regular usage of those buildings in support of research and development operations. LaRC does not withdraw water from any surface water resources and does not have any collection or treatment facilities. The Center operates under three discharge permits: one from the Hampton Roads Sanitary District for nonhazardous industrial wastewater and sanitary discharges, and two from the State of Virginia. The State permits govern surface water discharge outfalls from stormwater and facility industrial wastewater, primarily from cooling towers. These discharges are monitored in accordance with permit requirements. Floodplains would be unaffected by Constellation Program activities at LaRC.

Constellation Program activities at LaRC would not be expected to adversely impact potable water demand (LaRC receives potable water from independent and municipal sources) or sanitary wastewater service provided to the Center.

4.1.1.7.4 Noise

None of the activities anticipated under the Proposed Action at LaRC would be expected to result in excessive or unusual noise. Noise that might result from the Proposed Action would likely be similar to the ongoing activities at the site.

The extent to which the Constellation Program might require use of existing wind tunnels and other research facilities at LaRC is not known at this time, but it is reasonable to assume that some of these facilities could be utilized. It is anticipated that the Transonic Dynamics Tunnel would be used to support the Constellation Program. It has a very low maximum operating noise level of 47 dBA (LaRC 2005).

Due to the size of the site, nature of nearby aviation activities, and lack of major residential development in the immediate vicinity of LaRC, there have not been significant community complaints regarding noise or vibrations from LaRC operations (LaRC 2005).

Construction activities from modifications to existing facilities could potentially be minor noise sources during construction. Once operational, none of the modified facilities would be expected to produce excessive or unusual noise.

In addition to the wind tunnel, supporting utility systems, and minor occasional noise generated at various research and test facilities at the site, the dominant sources of additional noise resulting from the Proposed Action would be vehicular (traffic) noise, electrical substation noise, and utility/cooling tower noise. Traffic noise would be approximately proportional to workforce levels for the Proposed Action.

4.1.1.7.5 Geology and Soils

Due to past activities, the geology and soil of LaRC can be described as previously disturbed. LaRC and Langley Air Force Base are jointly listed on the CERCLA National Priorities List (EPA 2006c) for soil and water contamination. Since there would be no major construction projects associated with the Proposed Action, there would be no impacts to current conditions.

4.1.1.7.6 Biological Resources

Constellation Program activities at LaRC would not be expected to adversely impact biological resources at or near the Center. Constellation Program activities would be conducted at existing facilities. No Federal or state-protected species would be adversely impacted by Constellation Program activities.

The Impact Dynamics Facility (Gantry) (Building 1297) is located approximately 200 m (656 ft) south of marsh wetlands very near a small patch of forested wetland. Should this facility be utilized, Constellation Program actions undertaken there should not adversely affect the wetlands.

4.1.1.7.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

4.1.1.7.8 Cultural Resources

Table 4-20 lists the historic facilities on LaRC that may be used by the Constellation Program. Although several of these properties may be modified to support Constellation activities, it is expected that most of these modifications would be minor and have little or no effect on the properties.

Use of the Impact Dynamics Facility (Gantry) (Building 1297), a National Historic Landmark, for drop testing the Crew Module, may require refurbishing or modification. NASA has completed consultation with the Virginia SHPO, the Advisory Council on Historic Preservation, and the National Park Service, notifying them of the proposed modifications. NASA will comply with Stipulation III of the Programmatic Agreement it has with the National Park Service and conduct Level I Historic American Engineering Record documentation of the Gantry. The Virginia SHPO has concurred with the proposed mitigation, indicating there would be no adverse effect to the Gantry from the proposed modifications (NASA 1989).

LaRC recently conducted a center-wide architectural survey to determine the historic status of several existing facilities that may be used by the Constellation Program. LaRC is awaiting final determination from the Virginia SHPO as to the historic status of these facilities, which are listed in Table 4-20. Any Constellation Program activities that may have an adverse effect on historic resources would be reviewed by the LaRC Historic Preservation Officer and conducted in consultation with the Virginia SHPO. An MOA would be developed and implemented for such actions, as appropriate. Potential mitigation activities are discussed in Chapter 5 of this Final PEIS.

There are no known archeological resources associated with Constellation Program activities; therefore, no impacts to archeological resources are anticipated.

4.1.1.7.9 Hazardous Materials and Hazardous Wastes

Activities under the Proposed Action would be expected to result in hazardous material use and hazardous waste generation similar to ongoing activities. Small-scale propulsion tests would require using minor amounts of propellants. Some small quantity of pyrotechnics could be used in testing at LaRC. Lead paint waste from repainting of the Gantry would be contained and disposed of in accordance with applicable State, Federal, and local regulations.

Table 4-20. Proposed LaRC Historic Facilities Supporting the Constellation Program

Government Facility	Proposed Use of Facility	Proposed Modifications to the Facility	Historic Status	Anticipated Adverse Effects to Historic Properties
Materials Research Lab (Building 1205)	Testing of materials and test components for Orion and Ares	None currently identified	TBD	None
Structures and Materials Lab (Building 1148)	Testing of materials and test components for Orion and Ares	None currently identified	TBD	None
COLTS Thermal Lab (Building 1256C)	Stress testing for Orion, small articles/thermal protective materials	None currently identified	TBD	None
Thermal Structures Lab (Building 1267)	Stress testing for Orion, small articles/thermal protective materials	None currently identified	TBD	None
Fabrication and Metals Technology Development Lab (Building 1232A)	Fabrication of models and test items for Orion and Ares	Floor modifications for new roll press.	TBD	None
CF4 Tunnel (Building 1275)	Scale model testing for Orion	None currently identified	TBD	None
Unitary Wind Tunnel (Building 1251)	Scale model wind tunnel testing for Orion and Ares	None currently identified	TBD	None
31-Inch Mach 10 Tunnel (Building 1251)	Scale model testing for Orion	None currently identified	TBD	None
Vertical Spin Tunnel (Building 645)	Scale model testing for Orion, including the Launch Abort System	None currently identified	TBD	None
Transonic Dynamics Tunnel (Building 648)	Scale model wind tunnel testing for Orion and Ares	Modify test equipment for wind tunnel models	TBD	None
Gas Dynamics Complex – 20-inch Mach 6 Tunnel (Building 1247D)	Scale model wind tunnel testing for Orion and Ares	None currently identified	TBD	None
Impact Dynamics Facility (Gantry) (Building 1297)	Orion drop tests	Replace elevator, complete painting of upper section and repair/replacement of components	NHL	None
Hangar (Building 1244)	Possible assembly of some large Orion flight test articles inside hangar	None currently identified	TBD	None

NHL = National Historic Landmark
TBD = To Be Determined (awaiting final determination from the State Historic Preservation Officer)

Wind tunnel testing could use carbon tetrafluoride (CF_4) and HFC-134a (1,1,1,2-tetrafluoroethane – a refrigerant gas) in closed systems. Both CF_4 and HFC-134a have high global warming potential; 6,500 and 1,300 times greater than CO_2 respectively. See Section 4.1.6.2 for the potential impacts of the Constellation Program on global climate change.

4.1.1.7.10 Transportation

Traffic levels on major roads and highways outside LaRC would not be expected to increase based on the Proposed Action. Transportation of Constellation Program components between contractor sites, LaRC, and other NASA Centers would strictly adhere to all DOT regulations and could use rail, airplane, flat-bed truck, or a combination thereof. Traffic within the Center is expected to remain at levels currently experienced.

4.1.1.7.11 Environmental Justice

The Proposed Action is not expected to produce any consequences related to Environmental Justice. The proposed building modifications and operation activities at LaRC would not be expected to result in adverse effects on human health and the environment. Thus, the implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the vicinity of LaRC.

NASA would continue to consider environmental justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy (see Section 4.1.1.1.11). Any disproportionately high or adverse human health or environmental effects of the Constellation Program at LaRC on minority or low-income populations would be identified and action would be taken to resolve public concern.

4.1.1.8 Ames Research Center

Table 4-21 summarizes the major activities currently anticipated at Ames Research Center (ARC) in support of the Constellation Program. At ARC, most of these reasonably foreseeable activities would be similar to ongoing activities conducted in support of NASA programs. As such, the environmental impacts of implementation of the Constellation Program at ARC would be expected to be similar to the environmental impacts of ongoing NASA programs, which have been documented in various environmental documents, including the ARC Environmental Resources Document (ARC 2005).

Table 4-21. Description of Constellation Program Work at ARC

Constellation Program Project	Project Responsibilities
Project Orion	Manage Orion Thermal Protection System development
Project Ares	Design and develop Ares I fault detection Ascent abort blast analysis
Mission Ops Project	Support design, development, test, and evaluation of command and control systems

4.1.1.8.1 Land Resources

Activities described under the Proposed Action would not conflict with current land use plans at ARC. In addition, since the Proposed Action would be within the Center's current scope of activity, no sensitive habitats would be impacted.

4.1.1.8.2 Air Resources

None of the activities anticipated under the Proposed Action at ARC would be expected to result in excessive or unusual emissions.

Emissions generated as a result of the Proposed Action would likely be much like the ongoing activities at the site. In addition to the minor occasional emissions generated at various research and test facilities, the dominant source of additional emissions as a result of the Proposed Action would be vehicular (traffic) emissions. Any long-term incremental changes in vehicular emissions due to the Proposed Action would be proportional to the size of the workforce and are not known at this time.

4.1.1.8.3 Water Resources

Quantities of wastewater generated by Constellation Program activities would not expect to require modifications to existing NPDES permits. No impacts to surface water or groundwater resources at ARC would be anticipated. Constellation Program activities would not impact floodplains at ARC.

Constellation Program activities would not be expected to adversely impact the sanitary wastewater treatment systems at ARC or increase the potable water demand beyond current system capacity.

4.1.1.8.4 Noise

None of the activities anticipated under the Proposed Action at ARC would be expected to result in excessive or unusual noise. The noise that might result from the Proposed Action at ARC site would be expected to be similar to the noise generated by the ongoing activities at the site.

Noise generated by wind tunnels and aircraft operations at ARC and Moffett Field has historically been a source of complaints from surrounding communities (ARC 2005). The extent to which the Constellation Program might require use of wind tunnels and other research facilities at ARC is not known, but it is reasonable to assume that use of some of these facilities would occur.

Construction activities for modifications to existing facilities could potentially be minor noise sources during construction. Once operational, none of the modified facilities that would support the Constellation Program would be expected to result in excessive or unusual noise.

In addition to the wind tunnel, supporting utility systems, and minor occasional noise generated at various research and test facilities at the site, the dominant source of additional noise as a result of the Proposed Action would likely be vehicular (traffic) noise, electrical substation noise, and utility/cooling tower noise. As indicated in Chapter 3, these types of routine noises are ongoing at

ARC, and because of the large size of the site and the nature of the nearby Moffett Field aircraft activities, these noise sources would not be expected to directly affect the offsite population.

4.1.1.8.5 Geology and Soils

Due to past activities, the soils and geology at ARC can be described as previously disturbed. Moffett Field is listed on the CERCLA National Priorities List (EPA 2006c), with other areas of ARC known to have soil contamination (see Section 3.1.8.5 for more details). Since there are no new construction anticipated under the Proposed Action there would be no impacts to current conditions.

4.1.1.8.6 Biological Resources

Constellation Program activities would not adversely impact biological resources or wetland resources at ARC. No Federal or state-protected species would be adversely impacted nor would any designated habitat or essential fish habitat.

4.1.1.8.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

4.1.1.8.8 Cultural Resources

Table 4-22 lists the historic facilities on ARC that may be used by the Constellation Program. No modifications to these facilities are currently identified. Thus, none of these properties would experience an adverse effect as defined in 36 CFR 800.5.

Table 4-22. Proposed ARC Historic Facilities Supporting the Constellation Program

Government Facility	Proposed Use of Facility	Proposed Modifications to the Facility	Historic Status	Anticipated Adverse Effects to Historic Properties
11-foot Transonic Tunnel (Building N227A) (part of Unitary Plan Wind Tunnel [Building N227])	Ares scale model testing.	None currently identified	NHL	None
Arc Jet Laboratory (Building N238)	Orion components and Thermal Protection System testing. Ares support.	Under evaluation to support Thermal Protection System testing	NRE	None
Unitary Plan Wind Tunnel (Building N227)	Orion components and Thermal Protection System testing. Ares support.	None currently identified	NHL	None

NRE = National Register Eligible (asset is eligible for listing on the National Register of Historic Places)
NHL = National Historic Landmark

Any Constellation Program activities that may have an adverse effect on these or other historic resources would be managed in accordance with the ARC Cultural Resources Management Plan and in consultation with the California SHPO. An MOA would be developed and implemented for such actions, as appropriate. Potential mitigation activities are discussed in Chapter 5 of this Final PEIS.

There are no known archeological resources associated with Constellation Program activities; therefore, no impacts to archeological resources are anticipated.

4.1.1.8.9 Hazardous Materials and Hazardous Wastes

Activities under the Proposed Action would entail hazardous material use and hazardous wastes would be generated as a result of these activities, which would be similar to ongoing activities. Modifying existing facilities may result in some temporary additional hazardous material use and/or hazardous waste generation. All hazardous waste would be handled and disposed of in accordance with current NASA practices and prescribed rules and regulations.

4.1.1.8.10 Transportation

Traffic levels on major roads and highways outside ARC would not be expected to increase based on the Proposed Action. Transportation of Constellation Program components between contractor sites, ARC, and other NASA Centers would strictly adhere to DOT regulations and could use rail, airplane, flat-bed truck, or a combination thereof. Traffic within the Center is expected to remain at current levels.

4.1.1.8.11 Environmental Justice

The Proposed Action is not expected to produce any consequences related to Environmental Justice. The proposed activities at ARC would not be expected to result in adverse effects on human health and the environment. Thus, the implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the vicinity of ARC.

NASA would continue to consider environmental justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy (see Section 4.1.1.1.11). Any disproportionately high or adverse human health or environmental effects of the Constellation Program at ARC on minority or low-income populations would be identified and action would be taken to resolve public concern.

4.1.1.9 White Sands Missile Range/Johnson Space Center White Sands Test Facility

Table 4-23 summarizes the major activities currently anticipated at the U.S. Army's White Sands Missile Range (WSMR) and NASA's JSC White Sands Test Facility (WSTF) in support of the Constellation Program.

Table 4-23. Description of Constellation Program Work at WSMR and WSTF

Constellation Program Project	Project Responsibilities
Project Orion	Conduct launch abort flights tests at WSMR Reaction Control System tests at WSTF
Project Ares	Thrust Vector Control and Reaction Control System testing at WSTF

The Constellation Program would perform uncrewed launch pad abort tests and ascent abort flight tests at WSMR to evaluate the effectiveness of the Launch Abort System. NASA has prepared the *Final Environmental Assessment for NASA Launch Abort System (LAS) Test Program, NASA Johnson Space Center, White Sands Test Facility, Las Cruces, New Mexico* (WSTF 2007b) which evaluates the potential environmental impacts of both the planned tests and construction necessary to support the tests.

Several of the facilities at WSTF and WSMR identified for potential use in the Constellation Program would require modification. Table 2-10 summarizes the proposed modifications to facilities which are being considered for use by the Constellation Program where the changes might impact historic facilities or the changes might have the potential for environmental impacts sufficient to require additional analysis under an EA or an EIS. See Section 4.1.1.9.8 for discussion of historic/cultural impacts associated with the construction activities. Modifications to launch complexes at WSMR are being addressed in separate NEPA documentation (WSTF 2007b).

4.1.1.9.1 Land Resources

Activities described under the Proposed Action would not conflict with the current land use plan at WSTF. Testing of the Thrust Vector Control and Reaction Control System would occur in existing WSTF 300 and 400 area Small Altitude Simulation Systems facilities. These facilities are currently being used for similar tests for Minuteman missiles and the Space Shuttle Program and would not require new construction. No impacts to land resources are expected.

Activities described under the Proposed Action also would not conflict with the current land use plan at WSMR. There are multiple recreation, wilderness, and wildlife areas that surround WSMR. The Trinity Site National Historic Landmark is contained within WSMR. None of these areas would be impacted by any actions described in the Proposed Action, as WSMR is regularly used for rocket and munitions tests.

The construction of a new launch complex and associated facilities at LC-32 is proposed for Launch Abort System pad abort and ascent abort testing at WSMR (WSTF 2007b). LC-32 is an existing launch site designed for rocket flight tests, which are typical activities carried out at WSMR. The areas downrange (along the Launch Abort System flight trajectory) are also used for landing other test rockets and vehicles at WSMR.

Impacts on airspace from the Proposed Action would be minimal. Proposed Launch Abort System testing would involve overflights of the range from LC-32 to downrange landing sites. For the two pad abort tests, the test articles would land within 1.3 km (0.8 mi) downrange from the launch pad. The test article would be recovered for post-flight inspections. For the up to four ascent abort flight tests proposed to demonstrate separation and recovery under flight conditions, the test articles are estimated to land within 114 km (71 mi) downrange from the launch pad. In all cases, the test articles would land within WSMR. The use of WSMR controlled airspace ensures that there is no impact on commercial air traffic. Activities would fall within the scope of normal activities in WSMR-controlled airspace. Coordination efforts would minimize any airspace conflicts with concurrent testing or training operations being conducted on WSMR.

4.1.1.9.2 Air Resources

During testing of the Thrust Vector Control and Reaction Control Systems at WSTF, monomethylhydrazine and nitrogen tetroxide are combined, producing water vapor and nitrogen as the primary combustion products. These emissions would be captured by the test facilities' vacuum systems. These facilities are currently being used for similar tests for Minuteman missiles and Space Shuttle Programs therefore no new types of air emissions are expected.

Construction at LC-32 at the WSMR would generate dust; thus, dust control measures such as spraying water from water trucks or dust suppressants would be used. Launch Abort System vehicle exhaust, combustion products from fuels burned in internal combustion engines, and dust raised by vehicles off unpaved roads would be the principal impacts to air quality as a result of Proposed Action activities.

Portable generators may also be used for construction. Depending on their proposed use and duration of use, permits may be required by the State of New Mexico to operate the generators.

Dust, or soil particulate matter, would be dispersed into the air at vehicle landing sites from vehicles impacting the ground and from recovery vehicles. However, only small quantities of dust would be generated during these short and infrequent events.

The most significant activity at WSTF and WSMR that would generate air emissions are the test launches at WSMR. Two launch pad abort tests and up to four ascent abort tests are planned. Each ascent abort test would use an Abort Test Booster. The Abort Test Boosters would collectively utilize 202,500 kg (445,500 lb) of solid propellant. Each Launch Abort System would use 2,300 kg (5,200 lbs) of solid propellant.

A maximum of 217 mt (239 tons) of propellant would be burned over the course of the pad abort and ascent abort tests. Preliminary estimates of air emissions were made using typical emission factors previously used for solid rocket motor air permit modeling (SECOR 2001). These factors or weight fractions (relative to the amount of burned polybutadiene acrylonitrile (PBAN) propellant) are 30 percent for total suspended particles (TSP), 12.5 percent for PM_{10}, 2.67 percent for NO_x, and 20.5 percent for HCl. Using these factors, the total expected emissions from the pad abort and ascent abort tests are 65 mt (72 tons) of TSP, 27 mt (30 tons) of PM_{10}, 5.8 mt (6.4 tons) of NO_x, and 44 mt (49 tons) of HCl. If the bounding assumption is made that all PM_{10} emissions are less than 2.5 microns in diameter, the $PM_{2.5}$ emissions may be conservatively estimated as 27 mt (30 tons).

The largest Abort Test Booster that would be used for Launch Abort System flight tests uses about 10 percent of the propellant of the five-segment First Stage planned for Ares I. As with similar launches of Space Shuttle SRBs, abort test launches would have minimal air quality impact at WSMR due to their short burn duration and the wide dispersion of the materials along the flight path. Testing the smaller Abort Test Boosters at WSMR would not be expected to exceed Federal regulatory limits.

The WSMR launch pads are distant from residential and commercial areas. As a result, exhaust clouds from Launch Abort System abort tests would be expected to dissipate and not measurably affect air quality in surrounding communities.

Based on daily activities at WSMR, and the short duration of the actual vehicle testing, there would be no long-term cumulative effects or significant impacts to air quality.

4.1.1.9.3 Water Resources

Launch Abort System testing at WSMR would not be expected to impact either surface water or groundwater resources nor generate substantial quantities of wastewater. At this time, there are no plans to substantially increase the workforce at WSMR or WSTF to accommodate Constellation Program activities, so no substantial increase in groundwater consumption would be expected.

4.1.1.9.4 Noise

Noise associated with the Constellation Program activities would include activities at WSTF in support of Launch Abort System tests, which are currently limited to assembly operations; launch pad and flight testing of the Launch Abort System at WSMR; and vehicular traffic associated with the workforce and special operations.

<u>WSTF Noise Impacts</u>

Launch Abort System test assembly operations would be typical of current activities at WSTF therefore would not generate noise impacts. Testing of the Thrust Vector Control and Reaction Control System would occur in existing facilities at WSTF and would not generate abnormal noise. A 7.2-km (4.5-mi) buffer zone separates WSTF's industrial area from the nearest private home further reducing the impacts of WSTF noise on the local community.

<u>WSMR Noise Impacts</u>

Construction activities at WSMR would create noise; however, they are not anticipated to exceed regulatory levels. Launch activities at the launch complex could create loud but short duration noise. For the safety of workers, proper protective equipment including hearing protection would be required. Any loud noise or vibration generated during testing activities would be infrequent and very short in duration, and is not expected to affect local wildlife. Additionally, the WSMR facility is a remote location with no nearby communities. Thus, the proposed testing would have no adverse impacts beyond the conditions that currently exist.

The noise generated from each launch would be roughly proportional to the amount of thrust of the launch vehicle. Short-term noise levels and overpressures generated from these rocket launches would be expected to be equal to or lower than past rocket launches at WSMR.

The impacts of the complete range of WSMR activities, including space vehicle and test rocket launches, were evaluated in the *Final White Sands Missile Range Range-Wide Environmental Impact Statement* (WSMR 1998). That EIS indicated that the launch complexes and airspace over WSMR were both major noise sources on the range. Training activities in the WSMR airspace include bomb delivery, Air Combat Command and Air National Guard air-to-air combat and supersonic flight tactics, and other military exercises. In addition, drone flights and tests of missiles, rockets, and space vehicles occur in WSMR airspace. Large areas of the airspace are used as safety buffer zones for missile and rocket firings (WSMR 1998).

With respect to rocket launches, the *Final White Sands Missile Range Range-Wide Environmental Impact Statement* indicated:

> *Effects on human health with respect to space system vehicle noise levels are not anticipated to be adverse. Space vehicle test rocket launches will produce short duration (less than one minute) noise levels of approximately 65 dBA, 6.4 km (4 mi) from the launch site. Launch site test stands and sound buffer zones should limit main engine propulsion system testing levels to 70 dBA. Test Support personnel not under protective cover supporting a launch or launch test will be required by WSMR safety regulations to use hearing protection devices. Personnel under cover would be afforded proper sound mitigation through sound attenuation building construction. Sonic boom noise footprints are anticipated to occur over unpopulated areas many miles uprange and downrange from the launch or recovery location during space system vehicle launch and reentry. The low intensity and extreme infrequency of these sonic booms is not expected to produce effects other than a startle reaction in those people who hear the boom. The relatively long duration of a space system vehicle sonic boom pressure wave also may rattle loose windows* (WSMR 1998).

The EIS also concluded that for the range of activities at the WSMR, including rocket launches:

> *The overall environmental consequences of noise on human health and wildlife due to WSMR testing and training activities are considered potentially adverse but mitigable… Each of the major noise source areas, assessed individually, is either not adverse or mitigable by providing hearing protection to WSMR personnel and avoiding sensitive wildlife. As a result, any cumulative effects of noise are also anticipated to be minimal* (WSMR 1998).

4.1.1.9.5 Geology and Soils

The greatest potential for soil disturbance would be associated with the landing of the Launch Abort System vehicle downrange. The effect of a test vehicle striking the ground would be variable depending on soil density at the landing site, and velocity of the vehicle at landing. Since the test vehicle is designed to support human life in the event of an emergency, the parachutes and other features required for a safe landing should decrease ground impact velocity and minimize soil disturbances at landing.

There would also be minimal soil disturbance at the launch site due to construction of new facilities. WSMR launch complexes are developed areas located on previously disturbed soil. Overall the soil and soil quality would not be significantly affected by the proposed Launch Abort System testing.

4.1.1.9.6 Biological Resources

The impacts of the proposed construction and Launch Abort System testing activities were evaluated in the *Final Environmental Assessment for NASA Launch Abort System (LAS) Test Program, NASA Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico* (WSTF 2007b) and are summarized here.

Construction and modification of the launch complex would occur in previously disturbed areas. No new vegetation disturbances would occur. Some vegetation could be disturbed at the Launch Abort System landing sites, but only a relatively small area would be anticipated to be affected. Ground vehicles would use existing roads when available, and travel a single in-and-out path when traveling off-road. Off-road traffic would be restricted in accordance with WSMR regulations to minimize disturbance and vegetation. Overall there would be no long-term significant impacts to site vegetation.

In the event of a launch vehicle failure, either due to vehicle malfunctions or intentional destruction by Range Safety, small fires could be initiated by burning propellant. Emergency fire response crews from WSMR and WSTF would be able to prevent such fires from spreading. Revegetation and best management practices to minimize erosion would be included in the recovery plan following a fire.

Wildlife could be affected due to launch pad construction activities and vehicle landing and recovery activities. Noise from sources such as vehicles, heavy machinery, and general human activities related to construction and other test activities would lead to species-specific reactions. Most small mammals would avoid excessive noise by retreating into burrows while larger more mobile species of mammals and birds would temporarily vacate the area. Reproductive activities of some small mammals and birds may be temporarily disrupted by noise and the presence of humans while other animals may become increasingly habituated and display little modification in behavior with ongoing exposure.

During the construction of the launch pad, a gantry support tower would be erected. Due to its size, Federal Aviation Administration (FAA)-approved lighting would be required. Towers pose a collision risk to migratory birds that typically travel in large flocks at night. There is also the possibility of daytime bird strikes from low-visibility structures and wires. Tower lights are known to confuse birds, which increases the likelihood of bird strikes. Also, depending on the final design of the tower, it could be an attractive nesting spot for some bird species.

Most migratory birds are not listed as threatened or endangered but are protected under the Migratory Bird Treaty Act. Mitigation factors that would reduce the potential for bird mortalities were identified in the *Final Environmental Assessment for NASA Launch Abort*

System (LAS) Test Program, NASA Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico and are summarized in Chapter 5 of this Final PEIS (WSTF 2007b).

Other potential consequences of testing activities include injury to fauna from flying debris or test articles. The probability that fauna would be directly hit by debris or the test vehicle is inherently low. Debris generated during a test flight or flight termination would be collected to minimize the impact to vegetation and wildlife.

No threatened, endangered, or sensitive species are known to occur at LC-32, or the proposed landing sites within WSMR. Therefore, is unlikely that Launch Abort System testing would affect any threatened, endangered, or sensitive species at WSMR.

4.1.1.9.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. Socioeconomic impacts can only be addressed at the Programmatic level. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

4.1.1.9.8 Cultural Resources

Table 4-24 lists the historic facilities on WSMR that may be used by the Constellation Program. Launch Abort System tests are proposed for launch at WSMR from LC-32; the Dog Site, LC-33, Lance Extended Range-4, and the Small Missile Range are considered as alternative locations.

Table 4-24. Proposed WSMR Historic Facilities Supporting the Constellation Program

Government Facility	Proposed Use of Facility	Proposed Modifications to the Facility	Historic Status	Anticipated Adverse Effects to Historic Properties
Launch Complex-33 (alternate location to Launch Complex-32)	Launch Abort System pad abort and ascent abort testing	Unknown	NRHP	Possible

NRHP = Asset is on the National Register of Historic Places

LC-33 is listed on the NRHP (DOI 2007a) and the V-2 Launching Site, located in the South Range Complex, is recognized as a Natural Historic Landmark (DOI 2007b). Based on previous surveys of LC-32, the proposed alternative complexes, and the proposed landing sites, there are no known cultural resources that would be affected by the proposed activities. LC-33 and the V-2 Launch Site are the closest (about 3.7 km [1.7 mi]) known resources that could be impacted. To confirm that the structural integrity of the historic buildings and structures are not affected, a vibration monitor would be installed prior to testing of the Launch Abort System.

There is also the potential of striking previously unknown subsurface archeological resources during construction. A dig permit describing the proposed location of construction would be required prior to any activities. In the event that a previously unknown resource is located, all activity would cease and an archeologist would be notified.

Any Constellation Program activities that may have an adverse effect on historic resources at WSMR/WSTF would be reviewed by the WSMR/WSTF Historic Preservation Officers and conducted in consultation with the New Mexico SHPO and applicable Tribal Historic Preservation Officer(s). Appropriate MOAs would be developed and implemented for such actions. Mitigation activities are discussed in Chapter 5 of this Final PEIS.

WSMR has identified four federally recognized Indian tribes with affiliations and interests in WSMR cultural resources: the Mescalero Apache Tribe of Mescalero, New Mexico; the Fort Sill Apache Business Committee of Apache, Oklahoma; the Pueblo of Isleta, New Mexico; and the Ysleta del Sur Pueblo of El Paso, Texas. Four traditional cultural properties have been identified on WSMR. Although all four are outside the range of the Proposed Action, WSMR would continue to consult with interested parties regarding possible adverse effects to traditional cultural properties.

4.1.1.9.9 Hazardous Materials and Hazardous Wastes

Activities described under the Proposed Action would result in hazardous materials being used. Testing of the Thrust Vector Control and Reaction Control Systems would occur in existing WSTF 300 and 400 area Small Altitude Simulation Systems facilities. The Thrust Vector Control and Reaction Control Systems use hazardous materials, including monomethylhydrazine and nitrogen tetroxide. The WSTF 300 and 400 area Small Altitude Simulation Systems facilities are currently being used for similar tests for Minuteman missiles and the Space Shuttle Program and handle these types of hazardous materials. The types and amounts of monomethylhydrazine and nitrogen tetroxide used for the Space Shuttle Program are comparable to that planned for the Constellation Program test activities.

The Constellation Program testing activities would generate hazardous wastes, similar to ongoing activities. Modifying existing facilities may result in some temporary additional hazardous material use and/or hazardous waste generation. All hazardous waste would be handled and disposed of in accordance with current NASA practices and prescribed regulations.

Launch Abort System testing at WSMR would utilize solid propellants for the booster and the Reaction Control System would utilize CO_2 and ethanol as propellants. As discussed in Section 4.1.1.9.2, a bounding estimate of the quantity of high-energy solid propellants to be used over the six planned Launch Abort System tests is less than 220,000 kg (480,000 lbs).

Following flight, hazardous materials in the spent Abort Test Booster, remaining fluid in liquid propellant Reaction Control System tanks, and potentially unexploded ordnance from test malfunctions would remain. Small debris may also be present. These materials would be recovered for final disposal and do not pose a significant source of solid or hazardous waste. For routine flights, the solid propellant is expected to be completely expended prior to landing. All hazardous material and hazardous wastes would be recovered immediately, transported, stored, and disposed of in accordance with WSMR regulations. No hazardous or toxic materials would be stored at LC-32. Non-hazardous waste would be handled as solid waste or non-regulated waste. All solid waste generated at WSMR is collected by an offsite contractor and is disposed of in the Otero County landfill (WSTF 2007b).

In the event of a failure of a test vehicle, NASA would have a contingency plan in place to handle the corrective action, as well as clean-up and disposal of the vehicle debris and any contaminated materials. WSMR would also be consulted on the preferred methods to rehabilitate the area if it is deemed necessary.

Some modifications would be required at the selected WSMR launch pad. This construction may involve the use of hazardous materials and the generation of hazardous wastes. In the unlikely event of accidental petroleum, oil, or lubricant spills, contaminated soil would be cleaned using the most appropriate remediation method.

4.1.1.9.10 Transportation

Traffic levels on major roads and highways outside WSMR would not be expected to increase based on the Proposed Action. The Launch Abort System test articles would be shipped to WSTF via rail or flat-bed truck strictly adhering to DOT regulations. After checkout and validation, the test articles would be transported via roadway from WSTF to the WSMR launch area. Approximately 16.1 km (10 mi) must be traveled over public roadway between WSTF and WSMR.

Increased vehicle traffic at LC-32 and the landing sites may result from the Proposed Action, but would not be considered significant. Existing roads and parking structures are considered adequate to handle the demands under the Proposed Action. The transportation of waste or hazardous materials would be in compliance with WSMR regulations. Only approved or existing routes would be used (WSTF 2007b).

Proposed activities may require occasional blocking of traffic on WSMR roads and U.S. Highway 70. The proposed testing program would not significantly affect transportation as roadblocks would impede vehicular traffic infrequently and only temporarily (WSTF 2007b).

4.1.1.9.11 Environmental Justice

The Proposed Action is not expected to produce any consequences related to Environmental Justice. Due to the size of the buffer zone between the test complexes (including construction sites) and the general public, the proposed activities at WSMR and WSTF would not be expected to generate pollutant emission levels or noise levels that would result in offsite adverse effects on human health and the environment. In addition, the downrange landing sites are remote (within the WSMR boundary) and not considered to be near populated areas. Thus, the implementation of the Constellation Program would not be expected to have disproportionately high or adverse human health or environmental effects on low-income or minority populations in the vicinity of WSTF/WSMR.

NASA would continue to consider environmental justice issues during the implementation of the Constellation Program consistent with NASA's agency-wide strategy (see Section 4.1.1.1.11). Any disproportionately high or adverse human health or environmental effects of the Constellation Program at WSMR and WSTF on low-income or minority populations would be identified and action would be taken to resolve public concern.

4.1.1.9.12 Launch Accidents

During Launch Abort System tests, Range Safety would be ensured through cooperation between NASA-WSTF and U.S. Army-WSMR personnel. The Constellation Program would operate under NASA's Range Safety Policy (NASA 2005c) and WSMR Regulation 385-17, "Missile Flight Safety." Beginning with pre-launch activities for the Launch Abort System test, the Range Safety team would review a variety of factors in their assessment of safe operating procedures. These factors include the status of the range (whether or not the range is cleared for test activities), launch complex, and range assets. As a safety precaution, personnel would be evacuated to safe areas during the launch and landing of the vehicle. At a minimum, viewers would be placed outside a safety buffer zone.

The Range Safety team also would monitor meteorological conditions to determine effects on the test event and the general public. During launch, the Range Safety Officer monitors the trajectory of the launch vehicle. The Launch Abort System would have a flight termination system to destroy the vehicle if abnormal functioning is detected during the flight. If the vehicle is found to be straying outside its assigned flight corridor, the Range Safety Officer would activate the flight termination sequence, which would eliminate the risk of impacts outside of the flight corridor. Under normal launch conditions, after landing the Range Safety team would monitor the landing site and determine when it is safe for recovery crews to locate the Launch Abort System test article and flight components.

The U.S. Army uses models (*e.g.*, exhaust diffusion and debris analysis) that are accepted by the Range Safety community to predict launch risks to the public and launch site personnel from launch tests at WSMR. Range Safety criteria and practices at WSMR would be similar to those currently employed at both KSC and CCAFS. The range (land area and airspace) would be closed to the general public during Launch Abort System tests and these tests would be monitored for any anomaly which would result in non-acceptable risk levels.

4.1.1.10 Other U.S. Government Facilities

Constellation Program activities associated with Dryden Flight Research Center (DFRC), Goddard Space Flight Center (GSFC), and Jet Propulsion Laboratory (JPL) would largely be limited to support roles that would include, but not be limited to, project management, engineering and data analysis, and procurement and administrative support. Only limited physical testing, fabrication, or assembly of Constellation Program components would be expected to be performed at these facilities. Activities at other U.S. Government facilities, such as U.S. Air Force's wind tunnels and other test facilities, would be expected be within the normal realm of operations at each facility.

If any modifications to buildings would be needed to support Constellation Program activities at these or other U.S. Government facilities, it is anticipated that these modifications would be minor, such as internal upgrades to electrical wiring and moving interior walls. Any future construction of new buildings or major modifications needed to support future Constellation Program activities at these facilities would be subject to separate NEPA review and documentation, as appropriate. Minor changes in personnel may be anticipated at these facilities; however, it is expected that such changes would not impact or burden existing baseline conditions. Furthermore, little or no impacts to land resources, air resources, water resources, noise, geology or soils, biological resources, socioeconomics, historical or cultural resources, hazardous materials or hazardous wastes, transportation, or environmental justice would be anticipated.

4.1.2 Potential Environmental Impacts at Commercial Facilities

4.1.2.1 Potential Environmental Impacts at Alliant Techsystems – Launch Systems Group – Clearfield and Promontory, Utah

Table 4-25 summarizes the major activities currently anticipated at Alliant Techsystems-Launch Systems Group (ATK) facilities in Clearfield and Promontory, Utah, in support of the Constellation Program.

Table 4-25. Description of Constellation Program Work at ATK

Constellation Program Project	Project Responsibilities
Project Ares	Prime Contractor for the Ares I First Stage Ares solid rocket motor segment manufacturing and refurbishment Ares solid rocket motor hot fire testing

At ATK, most of the reasonably foreseeable activities are similar to ongoing activities conducted in support of the Space Shuttle Program. The environmental impacts associated with implementing the Constellation Program at this site would be similar to the ongoing actions undertaken to support the Space Shuttle.

For the Constellation Program, ATK would provide solid rocket motors for the Ares I First Stage and the Ares V SRBs. ATK may perform additional work for the Constellation Program awarded through competitive procurements. Most of these activities would be expected to be within the scope of activities normally undertaken at ATK.

The Promontory facility has been ground testing solid rocket motors since the late 1950s and continues to be used for solid propellant fabrication and solid rocket motor production, using both PBAN and HTPB propellant binders, and testing of solid rocket motors. Current launch vehicles/missiles supported include Delta II, Delta IV, Minuteman, and the Space Shuttle. Figure 4-10 illustrates ground testing of a five-segment solid rocket motor at Promontory, Utah.

The Clearfield Refurbishment Center (CRC) is located in Davis County north of Salt Lake City and is used to refurbish solid rocket motor hardware for the Space Shuttle Program.

4.1.2.1.1 Land Resources

Activities described under the Proposed Action would not conflict with current land use plans at either the Promontory facility or the CRC. There are no coastal areas, critical habitats, or essential fish habitats within or in close proximity to either facility. Primary land use outside the Promontory facility solid rocket motor production and test areas is livestock grazing.

Source: ATK 2006

Figure 4-10. Test Firing of a Five-Segment Solid Rocket Motor at Promontory, Utah

4.1.2.1.2 Air Resources

Activities Generating Emissions

Most Constellation Program production activities that generate air emissions at the ATK sites would be expected to produce emissions at the same levels as current operations (*e.g.*, boilers, emergency generators, paint booths, wastewater treatment, degreasers, grit blasters, and solvent usage). Any changes in these activities would likely be minor compared to those emission levels from solid rocket motor testing.

The new five-segment solid rocket motors for the Constellation Program would be test-fired at existing test stands at the Promontory facility. Air emissions from test firings were estimated for the solid rocket engine tests and flights identified in Table 2-11, a total of five solid rocket motor tests from 2008 to 2012.

The expected emission from test firings of five-segment solid rocket motors would be similar to emissions from an Ares I launch from KSC with the exception that all of the propellant would be ignited at ground level at ATK's T-97 test site. The extent and amount of deposition from the exhaust cloud would be similar to levels currently experienced during testing for the Space Shuttle Program.

The duration of each test firing would be approximately 124 seconds, in which 640,000 kg (1.4 million lb) of solid propellant would be burned. Emissions would primarily consist of HCl, NO_x, particulate matter, and suspended particles. Based on the emission factors developed for the *Space Shuttle Advanced Solid Rocket Motor Program* EIS (MSFC 1989), the weight percent of emissions for PBAN propellant are 30 percent Al_2O_3, 24 percent CO, 3.5 percent CO_2, 21 percent HCl, 9.5 percent water, nine percent nitrogen, two percent hydrogen, and one percent other products. Thus, each test firing of a five-segment solid rocket motor would produce approximately 190 mt (210 tons) of Al_2O_3, 150 mt (170 tons) of CO, 22 mt (24 tons) of CO_2, 130 mt (150 tons) of HCl, 60 mt (66 tons) of water, 57 mt (63 tons) of nitrogen, 12.8 mt (14 tons) of hydrogen, and 6.4 mt (7.0 tons) of other materials. Therefore, the cumulative airborne releases associated with ground testing solid rocket motors for the Constellation Program (based on the planned five tests) from 2008 to 2012 would include approximately 950 mt (1,100 tons) of Al_2O_3, 760 mt (840 tons) of CO, 110 mt (120 tons) of CO_2, and 670 mt (740 tons) of HCl.

Air quality measurements conducted previously have indicated the primary emissions of concern, HCl, NO_x, and particulate matter, from ground test firings of solid rocket motors at the Promontory facility were well below Federal and Utah regulatory limits. This facility is in an attainment area and operates under a CAA Title V permit, which includes ground firings of solid rocket motors (also see Section 4.1.6.2).

4.1.2.1.3 Water Resources

Constellation Program activities at the Promontory facility and CRC would not be expected to result in the generation and discharge of wastewaters in excess of those allowed under current facility discharge permits administered under State of Utah laws and regulations. As with current operating practice, all wastewaters at the Promontory facility would be treated prior to discharge under Utah Pollution Discharge Elimination System permit UT0024805. Liquid wastes are no longer discharged to unlined surface impoundments (see Section 4.1.2.1.9); therefore, surface water and groundwater resources would not be adversely impacted from Constellation Program activities.

At the Promontory facility, ongoing studies at old inactive landfill sites under the Resource Conservation and Recovery Act (RCRA) would not be adversely affected.

4.1.2.1.4 Noise

The Proposed Action would not result in any new types of noise sources introduced into either the CRC or Promontory sites. Under the Proposed Action, ATK would continue to manufacture and test solid rocket motors similar to ongoing activities in support of the Space Shuttle Program. The noise sources associated with manufacturing operations and rail, truck, and other vehicular activities would be similar to those for ongoing activities in support of the Space Shuttle and other solid rocket motor production programs.

The CRC is located in a high-density industrial complex and the Promontory facility is located in a sparsely populated area where the nearest house is approximately 5 km (3 mi) away. For both facilities, areas where the noise levels can exceed 85 dBA have been identified as being on-site and have been mapped. Hearing protection is required in these areas. The bulk of operations in the noise hazard areas produce noise levels that range from 90 to 95 dBA with a few, such as grit blasting operations, producing noise levels between 100 and 105 dBA. Most activities occur within enclosed structures and noise levels are significantly attenuated before reaching populated areas. Under the Proposed Action, the production of solid rocket motors for the Constellation Program would follow existing production processes with corresponding noise levels.

As a part of the past and ongoing programs, ATK has conducted test firings of solid rocket motors at its Promontory facility. Each test firing results in high noise levels in the immediate vicinity of the test area for approximately two minutes.

ATK has conducted a full scale test of the five-segment solid rocket motors similar to that proposed for the Ares launch vehicles. A five-segment solid rocket motor burns 640,000 kg (1.4 million lbs) of propellant in just over two minutes, which is similar in duration to a four-segment solid rocket motor. The currently envisioned final design of the five-segment solid rocket motor planned for the Constellation Program would, as compared with a four-segment solid rocket motor, contain 24 percent more propellant, deliver seven percent more thrust, and burn at a rate that is six percent lower. Since the acoustic noise and vibration from a solid rocket motor is generally proportional to the logarithm of the energy released, the expected differences in the noise generated by the five-segment and the four-segment solid rocket motors would be minimal. Overall noise levels have been comparable to the four-segment solid rocket motors used for the Space Shuttle.

The noise generated by four-segment solid rocket motor test firings was calculated for the *Final Environmental Impact Statement for the Space Shuttle Program* (NASA 1978). That analysis indicated that the noise generated by a test firing is locally intense with predominantly low frequencies. The maximum predicted sound level from a ground test firing at the Promontory facility to which the public might be exposed was 95 dBA on State Route 83. The 24-hour time-weighted average (Leq) corresponding to this sound level (for a 20- min test) is 67 dBA, assuming a background noise level of 60 dBA, which is less than EPA's daytime 70 dBA limit for hearing protection. Measured values have been significantly less than calculated values, showing the calculations to be conservative. Sound levels of 80 to 83 dBA were measured on State Road 83 during tests in 1977 (NASA 1978).

Although no direct noise-related health effects would result from these tests, large areas would be subjected to sound pressures of 100 dBA or more, predominantly at low frequencies. Temporary disturbance to nearby wildlife would be possible.

At the CRC site, there are no major noise sources that would impact areas outside of the site. There are also no sensitive noise receptors in the immediate vicinity of CRC (ATK 2006).

4.1.2.1.5 Geology and Soils

The soils and geology underlying all of CRC are described as previously disturbed and paved. Portions of the Promontory facility are highly disturbed while others are not.

The T-97 test facility at the Promontory facility would be upgraded to accommodate Constellation Program solid rocket motor testing. No impacts to geology or soils are anticipated.

There are no construction or refurbishment plans scheduled for the CRC; therefore, there would be no impacts to soils or geology associated with the Proposed Action at the CRC.

4.1.2.1.6 Biological Resources

Biological resources at both the Promontory facility and CRC would not be adversely impacted. There are no Federal or state-protected species or habitats on either of ATK's facilities, although the federally protected bald eagle (*Haliaeetus leucocephalus*) and federally threatened snowy plover (*Charadrius alexandrinus)* have been found in the vicinity of the Promontory facility.

4.1.2.1.7 Socioeconomics

The Constellation Program is in the early stages of development. Since Program budget requests have not been identified beyond fiscal year 2012 and major procurements associated with Program implementation are not yet awarded, a complete analysis of socioeconomic impacts by region would not be possible or meaningful at this time. See Section 4.1.5 for more details on the potential socioeconomic impacts of implementing the Constellation Program.

4.1.2.1.8 Cultural Resources

Buildings and structures already in use for the Space Shuttle Program would continue to be used for the Constellation Program. No properties listed in the NRHP are located at either facility. No specific Native American issues have been identified directly associated with the ATK locations.

4.1.2.1.9 Hazardous Materials and Hazardous Wastes

<u>Hazardous Material Use</u>

Many of the same or similar hazardous materials currently used for the ongoing Space Shuttle Program would be required for the Constellation Program. Ares solid rocket motor cases would be expected to be insulated with a newly formulated insulating material. The current insulating materials used for the Space Shuttle solid rocket motors (acrylonitrile butadiene rubber, asbestos, and silicon dioxide and/or silica-filled ethylene propylene diene monomer) are being replaced to eliminate the chrysotile (asbestos) fiber. Each Ares solid rocket motor would require approximately the same amount of insulation as a Space Shuttle SRB (15,500 kg [34,000 lb]).

<u>Propellants</u>

As for the Space Shuttle Program solid rocket motors, propellant for the Ares solid rocket motors would consist of a PBAN binder, epoxy curing agent, ammonium perchlorate oxidizer, and aluminum powder fuel. Small quantities of iron oxide (as ferric oxide) are added to normalize the burn rate. Propellant ingredients and approximate quantities per solid rocket motor are:

Aluminum Powder	100,000 kg	(220,000 lb)
Ammonium Perchlorate	435,000 kg	(957,000 lb)
HB Polymer	75,000 kg	(165,000 lb)
Epoxy Resin	12,300 kg	(27,000 lb)
Ferric Oxide	1,860 kg	(4,100 lb)

Quantities of propellant that would be produced annually for the Space Shuttle Program and the Constellation Program at the Promontory facility are shown in Table 4-26.

Table 4-26. Projected Propellant Production at ATK

Year	Propellant Produced per Year in Millions of Pounds*		
	Constellation Program	Space Shuttle Program	Total
2006	0	4.1	4.1
2007	0	9.7	9.7
2008	4.1	9.7	13.8
2009	0	4.4	4.4
2010	4.1	0	4.1
2011	5.5	0	5.5
2012	6.9	0	6.9
2013	6.9	0	6.9
2014	9.6	0	9.6
2015	9.6	0	9.6
2016	8.2	0	8.2
2017	5.5	0	5.5
2018	9.6	0	9.6
2019	9.6	0	9.6
2020	9.6	0	9.6

* See conversion table on page xxiii for metric units

Ozone Depleting Substances

The design for the Ares solid rocket motors assumes the continued use of 1,1,1-trichloroethane (TCA). NASA and ATK have an EPA essential use exemption for the use of TCA for tackifying rubber and in other critical bonding operations. In 2004, NASA purchased and stockpiled 75,000 l (20,000 gal) of TCA to support its solid rocket motor production through 2020. The TCA is stored in five 15,000 l (4,000 gal) tanks in two separate locations. It is used at the rate of approximately 371 l (98 gal) per solid rocket motor. The EPA has concurred with the continued use of TCA on solid rocket motors for the Constellation Program for the same functional purposes as approved for the Space Shuttle Program and for the same period (EPA 2007b).

ATK also uses small quantities of HCFC 141b in foam used to fill test holes in foam insulation on the exterior surface of the Space Shuttle solid rocket motors (current rate of use is 12 kg/year [26 lb/yr]). ATK is currently working with NASA to determine the requirements for the Ares I First Stage. See Section 4.1.1.3.2 for additional information.

Hazardous Waste Generation

Until 1988, ATK had been disposing contaminated liquid wastes in an unlined impoundment at the Promontory facility. The area was contaminated with trichloroethene (TCE) and perchlorate. Currently, all waste disposal actions meet current state and Federal regulatory standards. There are other solid waste units at the Promontory facility currently undergoing state investigation.

Solid rocket motor production for the Constellation Program would generate hazardous wastes. It is anticipated that the types and amounts would be consistent with current operations and include waste propellant, paints, coatings, solvents, cleaning rags, catalysts, curing agents, polymers, and similar compounds. In 2004, the CRC and Promontory facilities collectively generated and disposed of or otherwise treated 1.1 million kg (2.4 million lb) of hazardous wastes. Hazardous waste is managed by offsite treatment and/or disposal at permitted facilities, onsite thermal treatment by open burning, and via onsite landfills.

4.1.2.1.10 Transportation

Traffic levels on major roads and highways outside the Promontory facility and CRC are not expected to increase based on the Proposed Action. Currently, ATK follows a rigorous routine when loading solid rocket motors containing solid propellant and transporting them to KSC. This process also includes the delivery and transport of fuel constituents between facilities. Each mode of transportation, rail or truck, must be certified to handle hazardous materials. Solid rocket motors are loaded into specialized railroad cars prior to transportation to KSC and are escorted by ATK personnel in transit to KSC. For more detail on the transport between the CRC, Promontory facility, and KSC see Section 3.2.1.7.

It is expected the Constellation Program would follow the same protocols as the Space Shuttle Program when transporting solid rocket motors. No adverse impacts to the public would be anticipated during transportation. Traffic within each ATK facility is expected to remain at levels currently experienced under the Space Shuttle Program.

4.1.2.1.11 Accidents

Accidents associated with the manufacture, testing, and transportation of solid rocket motors for the Space Shuttle Program, as well as other programs at ATK, have been evaluated in a number of safety analyses and environmental documents, including the *Final Environmental Impact Statement for the Space Shuttle Advanced Solid Rocket Motor Program* (MSFC 1989). That EIS evaluated potential accidents associated with the production, testing, and transportation of four-segment solid rocket motors and concluded that accident consequences could include:

- Possible explosion, fire, and loss of life during manufacture of raw materials and production
- Possible truck or rail accidents resulting in material spills, with possible explosion or fire
- Accidental detonation resulting in loss of life or production capability
- Accidental release of asbestos, chemical vapors, and discharge of solvents during refurbishing.

Each of these types of accidents is addressed in current ATK safety plans and procedures in order to prevent their occurrence, to the extent practicable, and to mitigate their consequences. Since the processes for production, testing, and shipment of solid rocket motors for the Constellation Program would be similar to the Space Shuttle Program, the potential accidents and consequences should be similar to those previously evaluated for the Space Shuttle Program. The major types of potential accidents would be expected to be similar if the Proposed Action were adopted.

Manufacturing Accidents

The production of solid rocket motors involves processing large quantities of materials that are highly flammable and, as such, require a great deal of care to ensure that major fires or explosions do not occur and threaten the lives of the workforce. The prevention of these process accidents is a central aspect of the safety programs at ATK. The potential localized impacts of these types of accidents were addressed in the *Final Environmental Impact Statement for the Space Shuttle Advanced Solid Rocket Motor Program* (MSFC 1989).

Although an unlikely event, an explosion during the mixing and casting process could result in damage to structures up to several hundred meters from the processing area. In March 1984, an explosion at the Promontory facility, then a Morton Thiokol plant, occurred while pouring uncured propellant. A blast over-pressure equivalent of 13.6 mt (15 tons) of trinitrotoluene (TNT) resulted from a violent explosion of over 113,000 kg (250,000 pounds) of uncured propellant. Due to quick personnel response and fortuitous circumstances, no injuries occurred beyond smoke inhalation and minor cuts and bruises. Blast and incendiary effects were observed up to several hundred meters from the point of explosion. Structural damage occurred to buildings 430 m (1,400 ft) from the blast area. Window breakage occurred as far as 1,200 m (4,000 ft) from the explosion area (MSFC 1989). All damage was confined within Morton Thiokol's facilities.

Modifications to equipment and facilities, including remote operations where practicable, as well as safety plans and procedures, are in place at ATK to reduce the probability of this type of accident.

Deflagration During Ground Testing

The presence of voids in cured rocket motor propellant can result in a locally increased burning rate within a motor being fired. This may produce excess pressure inside the case, leading to case rupture. Case rupture also may occur as the result of structural flaws in the case, including the insulation, seals, adhesives, or other case materials. Explosive effects associated with the case rupture of a four-segment solid rocket motor during ground testing have been evaluated (MSFC 1989). If the case rupture were to occur near the end of a test firing, when the maximum volume of pressurized gases is contained in the case, an explosion equivalent to approximately 1,500 kg (3,300 lb) of TNT could occur. This is the maximum conceivable energy release for a case rupture. An explosion of this magnitude could be inferred to have the following effects:

- Lethality at distances of up to 19 m (62 ft)
- Structural damage of massive multi-story buildings at distances of up to 19 m (62 ft)
- Lung damage at distances of up to 35 m (115 ft)
- Total structural damage of light-frame construction at distances of up to 50 m (164 ft)
- Ear drum rupture at distances of up to 65 m (213 ft)
- Window glass breakage at distances of up to 220 m (720 ft).

Case rupture also would allow propellant to spill out onto the ground as an uncontrolled fire. Since the Promontory test firing area would be cleaned of other combustible materials, a fire of this type would simply burn until the available fuel was consumed (MSFC 1989). A deflagration involving a five-segment solid rocket motor could involve up to 25 percent more propellant and theoretically result in similar consequences as the four-segment solid rocket motor, but out to farther distances.

Transportation Accidents

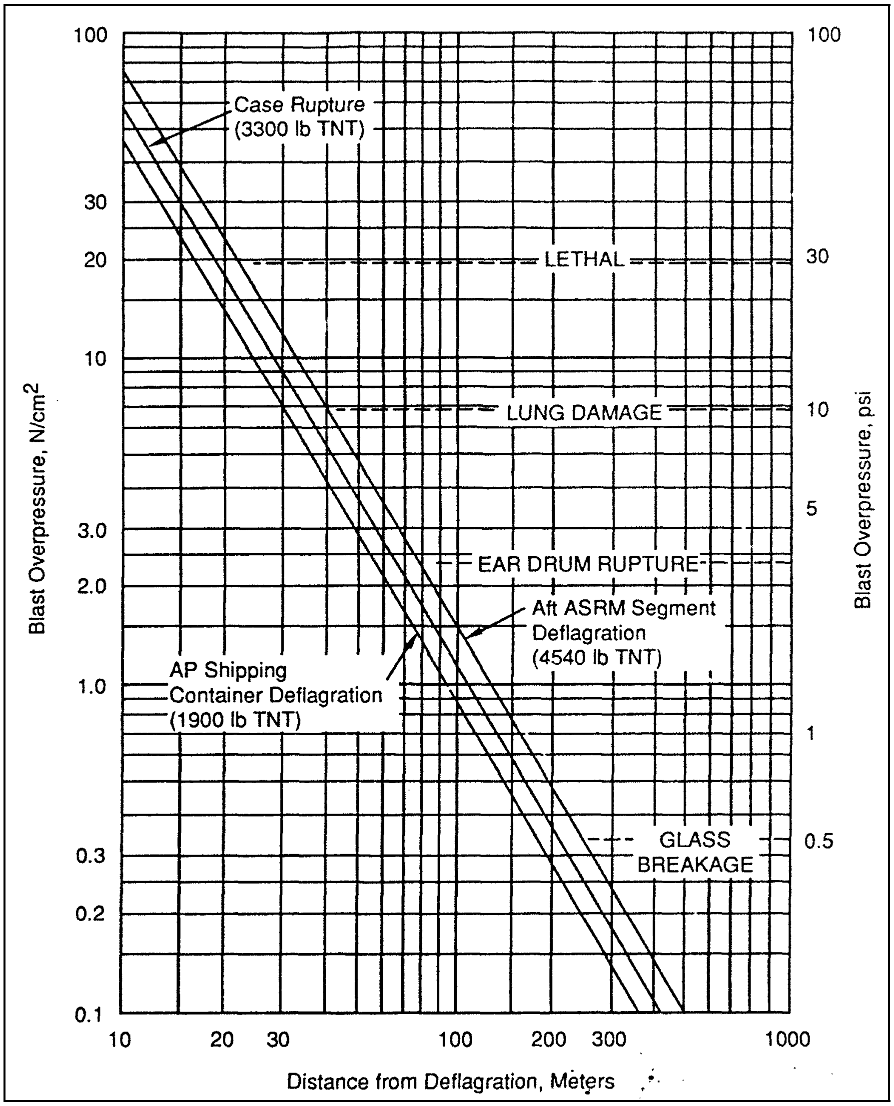
The primary transportation hazard relates to the potential for accidents involving fueled solid rocket motor segments. Each Space Shuttle solid rocket motor segment contains an average of 136,000 kg (300,000 lb) of propellant, which, under accident conditions, might ignite and burn at a high rate. Depending on location and surrounding conditions, such an event could potentially have serious consequences. Ignition of a solid rocket motor segment could be caused by high temperature, static discharge, or impact. The most likely origin of these conditions would be a transportation accident, such as a collision or train derailment, and vandalism or sabotage. Environmental influences would be unlikely to cause ignition, although static discharge in the form of lightning could not be ruled out. Specific triggering mechanisms from a train or truck accident could include fires or explosions resulting from the ignition of other hazardous materials in the same shipment or at the accident site (MSFC 1989).

The initial consequences of accidental ignition of Space Shuttle solid rocket motors were estimated based on propellant volume and ignition characteristics (MSFC 1989). Those analyses indicated that the accident scenarios identified above, including sabotage with high explosives, would at most cause rapid burning with a low equivalent explosive yield. A worst-case scenario involving detonation of other explosives on a nearby railcar would not detonate the solid rocket motors. Blast wave damage from rapid burning with low explosive yield would cause total destruction for light frame construction within 50 m (164 ft), and major repair would be required for such buildings within 105 m (345 ft). A blast of this level would rupture ear drums of people within 60 m (197 ft) of the accident site (Figure 4-11). Ignition of a solid rocket motor segment also would produce potentially hazardous air emissions, particularly HCl and $A1_2O_3$, but evaluation of the peak concentrations and duration indicated that little or no health impact from these emissions would result (MSFC 1989).

The actual impacts of an accident resulting in solid rocket motor ignition and fire would depend on where the accident occurred. Direct damage from a solid rocket motor blast wave and burning, plus potential secondary fires or explosions, would be greater in urban or built-up areas.

Rail transportation has been used approximately 300 times to transport fueled Space Shuttle solid rocket motors from Utah to KSC. Each of these has been followed with a return trip, and in about 10 instances, the return trips have carried fueled segments. Each of these shipments was conducted safely with no instances of accidental ignition. These shipments comply with applicable DOT regulations for rail shipment of hazardous materials. As such, minor rail incidents, such as train derailments, have not resulted in ignition of the solid propellant.

On May 2, 2007, a train transporting Space Shuttle solid rocket motors and a passenger car with technicians on board to monitor their transportation derailed near Linden, Alabama when a railroad bridge (trestle) collapsed under the locomotives. Six people were injured when the two locomotives and the passenger car dropped about 3 m (10 ft) and turned on their sides. One of the railcars carrying a solid rocket motor segments also fell on its side and three other railcars and segments experienced a jarring drop. The four other railcars containing segments remained upright and undamaged. As was expected with the safety precautions taken with each shipment, the incident did not result in ignition of the solid propellant (NASA 2007c).



Source: MSFC 1989

Figure 4-11. Potential Impacts from Transportation Accidents

4.1.2.2 Other Commercial Facilities

The Constellation Program would be supported by various other commercial facilities throughout the U.S., including facilities that are owned and operated by the Lockheed Martin Corporation and the Boeing Company. Many competitive procurements remain to be awarded and thus many other commercial facilities would be expected to support the Constellation Program. It is expected that the activities engaged in at each commercial facility involved in the Constellation Program would fall within the normal realm of operations at each facility. It is also expected that all such facilities would be in compliance with all applicable Federal, state, and local environmental laws, regulations, and permits. NASA would ensure that this is the case as a matter of contract with all commercial entities selected to support the Constellation Program.

4.1.3 Potential Environmental Impacts of Jettisoned Launch Vehicle Components on the Ocean

This section describes the potential impacts of ocean splash down of Ares I and Ares V jettisoned components during the ascent phase for launches from KSC, as well as similar vehicle elements from KSC test launches. Ares I components would include the First Stage, Upper Stage, Spacecraft Adapter, payload shrouds, and the Launch Abort System. The Ares V components would include the SRBs, Core Stage, Earth Departure Stage, Spacecraft Adapter, and payload shrouds. Many aspects of the launch trajectory and element disposition, including downrange splash down and recovery of jettisoned components, and impact and disposal of spent Ares launch vehicle Stages would be similar to Space Shuttle operations.

NASA Range Safety procedures require jettisoned launch vehicle components be considered in demonstrating that the overall approved mission risk limits/safety requirements would be met (NPR 8715.5 [NASA 2005c]). These requirements dictate that the landing areas for the jettisoned components be selected such that the likelihood of impacting structures, ships, or people is very remote. These safety requirements are the same as are currently imposed on the Space Shuttle Program.

4.1.3.1 Normal Launch

Ares I Launch

The Ares I First Stage would deplete its propellant load just over two minutes after launch and would be jettisoned into the Atlantic Ocean for recovery (see Figure 2-8 for the Ares I launch profile). Typically, the First Stage would splash down approximately 80 to 460 km (150 to 250 mi) downrange in a predetermined area of the Atlantic Ocean. Several First Stage components (*e.g.*, the forward section frustum, interstage) would be jettisoned and would not be recovered. The processes for recovery of the First Stage would be similar to those currently used for the Space Shuttle SRB recovery. The Constellation Program is currently studying the option of not recovering the spent First Stage for certain missions.

After Upper Stage ignition, the Launch Abort System would be jettisoned (after it is no longer needed to accomplish a safe abort), land in the Atlantic Ocean, and sink to the ocean bottom. The approximately 2,300 kg (5,200 lb) of solid propellant in the Launch Abort System would be expected to slowly dissolve in the ocean waters. Because of the slow rate of dissolution and the availability of large quantities of ocean water, toxic concentrations are not expected except in the immediate vicinity of the propellant. No mortality of marine biota would be anticipated.

The Service Module shrouds would be jettisoned during the Upper Stage ignition over the Atlantic Ocean and would not be recovered (JSC 2006c).

After burnout, the Ares I Upper Stage containing LOX/LH tanks, nozzles, pyrotechnics from the destruct system, other hardware, and the Orion spacecraft adapter would separate from Orion and would be targeted to land in the Indian Ocean. These components would not be recovered.

Ares V Launch

Following a launch profile very similar to the Space Shuttle, the Ares V SRBs would be jettisoned into the Atlantic Ocean (see Figure 2-13 for the Ares V launch profile). The splash down zones and the recovery processes would be similar to those described above for the Ares I First Stage and as currently practiced for the Space Shuttle SRB recovery. The Constellation Program is currently studying the option of not recovering the spent SRBs for certain missions.

The Ares V payload shroud, the Core Stage containing LOX/LH tanks, nozzles, pyrotechnics from the destruct system, and other hardware, and the Earth Departure Stage adapter would be targeted to land in the Indian or Pacific Ocean depending on final trajectory design. These components would not be recovered.

4.1.3.1.1 Environmental Impacts of Ocean Disposal

A residual amount of hydraulic fluid and hypergolic propellants would remain in the launch vehicle stages when they fall into the ocean. If released, the fluid and propellants would be diluted by seawater and would not be expected to affect marine species (USAF 1998).

The introduction of soluble products into an ocean environment from Launch Abort System solid propellant and residual solid propellant from the Ares I First Stage and the Ares V SRBs would be expected to produce short-term, localized impacts (NASA 1996). The potential for solid propellants to dissolve in sea water has been evaluated previously (AFRL 1998, Aerospace 2001, Aerospace 2002). These propellants, as they dissolve, release ammonium perchlorate, which has been shown to be toxic. Studies (TRW 2002) have indicated that the biological effects of perchlorate in seawater principally occur when perchlorate levels are extremely high (1,000 ppm). Because any perchlorate leached from solid propellants used for the Constellation Program would be quickly diluted, toxic concentrations would not likely remain. In addition, because of the limited number of launch events scheduled, the small amount of residual propellants present, and the very large volume of water available for dilution, any adverse impacts from the jettisoned launch vehicle stages would be limited.

Vehicle elements not recovered, possibly including Ares I First Stage and Ares V SRBs for some missions, while not totally inert, would dissolve slowly, dissipate, and become buried in the ocean bottom. Corrosion of stage hardware would contribute various metal ions to the water column; however, due to the slow rate of corrosion in the deep ocean environment and the quantity of water available for dilution, toxic concentrations of metals are not likely to occur (USAF 1998, NASA 2005b, NASA 2006d). Because of the limited number of launch events scheduled and the very large volume of water available for dilution, no adverse impacts would be expected from the nonfuel materials associated with the jettisoned launch vehicle stages (USAF 1998).

It is likely that the density of marine mammals in the splash down zones would be low; therefore, the probability of vehicle elements striking animals is small. These items would likely sink and smother organisms in the immediate area of contact on the ocean bottom (USAF 1998); however, this is expected to have a localized and negligible impact.

For Ares launches, the size and location of the debris fields produced by the jettisoned stages would be specified based on the vehicle's trajectory. NASA would ensure that "Notices to Mariners" and "Notices to Airmen" (NOTAM) would be provided prior to any launch (for the launch area and downrange areas at risk from falling debris or jettisoned stages) to reduce the risk to aircraft and surface vessels.

4.1.3.1.2 Ocean Recovery of the Ares I First Stage and Ares V SRBs

Transit of recovery vessels from KSC to the Ares I First Stage and Ares V SRB splash down zone is expected to be similar to the ongoing operations for the Space Shuttle Program. The recovery team and the ships would be pre-deployed to the planned splash down site in the Atlantic Ocean (JSC 2006c).

During transit, the recovery ships would necessarily carry fuels and potentially other hazardous materials. Requirements of applicable international agreements would be observed as release of potentially hazardous materials at the port or ocean environment could cause environmental impacts. Maritime protocol would be followed to prevent collisions and protect the cargo integrity in the same way as any other seagoing vessel carrying hazardous materials. The overall likelihood of ecological damage and impact from transit should be minimal because the splash down zones would be in the open ocean, which is less biologically rich than upwelling and coastal areas.

After splash down of the Ares I First Stage or Ares V SRBs, the recovery team would ensure that these were safe, and they would be prepared (including parachutes) for return to KSC. The Ares I First Stage and the Ares V SRBs would be dismantled and would be transported to ATK for refurbishment.

The possibility exists that the solid rocket motors may not be retrievable, with a resulting impact to the environment similar to that described previously for Ares I First Stage or Ares V SRBs not planned to be recovered. The environment also could be impacted by a recovery ship accident, or as a result of jettisoned components hitting a ship or aircraft. This possibility would be minimized by the issuance of Notices to Mariners and NOTAMs prior to the launch as described above.

4.1.3.2 Launch Accidents

In the event of an anomalous launch, the point in the launch sequence when the failure occurs determines the impact on the environment. The environmental impacts of accidents that result in vehicle components hitting the ground on or near the launch pad or in the KSC vicinity are discussed in Section 4.1.1.1.12. Accidents that occur at higher altitudes could result in launch vehicle components falling into the ocean or impacting land, depending on when the accident occurs. A discussion of these accidents follows.

Early-Ascent Aborts/Accidents

For both early-ascent aborts (*i.e.*, aborts prior to jettisoning any launch vehicle components) and early-ascent accidents, parts of the vehicle would fall back to Earth, with the fragments falling into the Atlantic Ocean. The predominant environmental impact of an early-ascent abort or accident would be from unspent fuel, launch vehicle debris, and unrecoverable stages. The magnitude of the environmental impact would depend on the physical properties of the materials (*e.g.*, size, composition, quantity, solubility) and the local marine biota of the impact region. It is expected that the metal components would slowly corrode. Toxic concentrations of metals would be unlikely because of slow corrosion rates and the large volume of ocean water available for dilution (USAF 1996, NASA 2006d).

During early-ascent aborts, the Crew Module would be separated from the Ares I/Orion Service Module using the Launch Abort System. Once the Launch Abort System motor burns out and sufficient separation from the launch vehicle is obtained, the Crew Module would descend via parachutes to the Atlantic Ocean where the crew (and the Crew Module) would be recovered. With an early-ascent abort, the Ares I disposal would occur via uncontrolled water impact or destruction via the flight termination system. In the event of an Ares V early-ascent anomaly, the vehicle disposal would also occur via uncontrolled water impact or destruction via the flight termination system.

The likelihood that launch vehicle stages or debris would strike a marine mammal is low due to the extent of the open ocean and the relatively low density of marine mammals in the surface waters of open ocean areas (USAF 1998).

Recovery operations following an early-ascent accident would be expected to have a negligible effect on the ocean environment.

Mid-Ascent Aborts/Accidents

Ares I mid-ascent aborts are aborts performed after Upper Stage separation from the First Stage and after the Launch Abort System has been jettisoned. Mid-ascent aborts do not result in an attempt to reach a targeted touchdown point, but entail a Crew Module trajectory adjustment to reduce recovery time.

A mid-ascent abort or mid-ascent accident of an Ares I or Ares V could result in impacts of debris along the vehicle flight path. If these objects fall over deep ocean waters, they would momentarily disrupt the environment as the warm objects are cooled and sink, with an extremely remote chance of striking a marine mammal.

Late-Ascent Aborts/Accidents

Ares I late-ascent aborts are aborts performed following a premature failure of the Upper Stage when the ascent trajectory has sufficient velocity to allow a Service Module engine burn to get the Crew Module to a suitable landing site or safe orbit. At abort initiation, the Crew Module/Service Module trajectory would be modified with a targeted Service Module engine burn and the Crew Module/Service Module would be maneuvered to an orientation suitable for separation. If landing immediately, the Crew Module and Service Module would separate, with the Crew Module then performing a guided Earth atmospheric entry to a suitable landing site. At the appropriate altitude, the parachutes would be deployed and the Crew Module would descend to a safe landing. If there is an abort to a safe orbit, the mission status would be evaluated and the mission would possibly be allowed to continue. If the decision is made to land, the mission will continue to landing similar to a normal return from the International Space Station. Thus, a late-ascent abort would have the lowest environmental impact of any type of anomalous launch.

At this point in the Constellation Program, landing sites for late-ascent aborts have not been determined, but the Orion spacecraft design would include the potential for an ocean landing of the Crew Module. Abort landing sites for the Crew Module could include Atlantic, Indian, and/or Pacific Ocean sites. Following late ascent aborts, the Crew Module may also be able to reach landing sites within the continental U.S.

In a late-ascent accident, each of the vehicle components would reenter and impact land or water under the flight path. In the event of private property damage, NASA has procedures in place to evaluate such damage and provide for compensation, if warranted. The potential environmental impacts would be very similar to those expected for a normal return of the Orion Crew Module and Service Module. These impacts are presented in more detail in the following sections.

4.1.4 Potential Environmental Impacts from Return to Earth of the Orion Crew Module and Service Module

NASA Range Safety procedures require jettisoned entry vehicle components be considered in demonstrating that the overall approved mission risk limits/safety requirements would be met (NPR 8715.5 [NASA 2005c]). These requirements dictate that the landing areas for the jettisoned components be selected such that the likelihood of impacting structures, ships, or people is very remote.

The environmental impacts of return of the Orion spacecraft, including Service Module and the docking mechanism (if from the International Space Station) would be minor, principally associated with sonic booms from Earth atmospheric entry. Other environmental impacts expected would be associated with development of terrestrial landing sites (if terrestrial landing sites are used), landing operations, and recovering the Orion spacecraft. Preliminary analyses of the primary site-independent environmental impacts, *i.e.*, those associated with sonic booms and jettisoned components, are evaluated in this Final PEIS in order to comprehensively understand the potential impacts of the Proposed Action.

The Constellation Program currently requires both terrestrial and water (ocean) landing capabilities for the Orion Crew Module's return to Earth. Any land landings under a normal return would be expected to occur in the western Continental United States. Among the driving considerations for the landing site are the orbital mechanics associated with safely disposing of the Service Module (and the docking mechanism for International Space Station mission return) in the ocean as the Crew Module is en route. As backup, NASA intends to maintain the ability to land the Orion Crew Module in the ocean. When the technical analyses of landing alternatives become more mature, NASA would prepare separate NEPA documentation addressing terrestrial landing sites, as appropriate.

The impacts of jettisoning the Service Module (and the docking mechanism for International Space Station mission return) in the Pacific Ocean, as well as the impacts of an ocean landing of the Orion Crew Module, are addressed in Section 4.1.4.2.

4.1.4.1 Impacts of the Orion Spacecraft Landing at a Western U.S. Terrestrial Site

While the Orion terrestrial landing site(s) have not been selected, the general characteristics important for a site are characterized as generally flat terrain, without marshes, forests, boulders or ravines, and unpopulated. The principal activities at the landing site would be recovery of the Orion Crew Module and crew for transport.

Terrestrial landing site candidates would be chosen within the western portion of the U.S. Therefore, given the possible approach direction of the Orion ranging from the southeast to northeast, the majority of the atmospheric entry trajectories and sonic boom footprints would be over the Pacific Ocean. There are no major land areas within these boundaries; therefore, environmental impacts would be expected to be negligible. However, as the Orion Crew Module passes over land areas, there could be structural and human exposure to sonic booms.

The landing site(s) would most likely be on existing government property. Some support facilities would be needed, which may or may not already be in place, depending on the site(s) selected. For a normal atmospheric entry and terrestrial landing of the Orion Crew Module, the spacecraft would land within a pre-designated restricted landing zone. This area would be cleared of personnel until after the Crew Module and any other items jettisoned during its descent and landing are on the ground. The Crew Module would descend through U.S. National Air Space in near-vertical flight; essentially the Crew Module would remain in a small vertical cylinder that extends from the ground to approximately 15,200 m (50,000 ft) of altitude. This airspace would be controlled with the assistance of the FAA. The confines of the landing location are defined as a 10 km (6.2 mi) diameter circle.

4.1.4.1.1 Potential Sonic Boom Impacts

During atmospheric entry, the Orion Crew Module would travel at supersonic velocities across large areas of land and water in preparation for landing. The velocities created by atmospheric entry would produce pressure waves, or sonic booms. Sonic booms are dependent, among other things, on the atmospheric entry trajectory, and the size, and velocity of the returning object. Atmospheric and meteorological conditions would affect the dispersion of the sonic boom and overpressure. Areas that fall under the atmospheric entry trajectory are subject to sonic booms created by the Orion Crew Module. Since the Orion spacecraft has not been built yet, there are no actual measurements of a sonic boom for Orion atmospheric entry available. The projected sonic boom footprint is discussed in the following sections.

The atmospheric entry of the Space Shuttle has been extensively studied, both with modeling and actual measurements. These activities led to the development of computer modeling tools that have been used to predict the sonic boom footprints for other atmospheric entry vehicles, such as the X-33 Advanced Technology Demonstrator Vehicle.

Sonic booms are measured in terms of pressure above the normal atmospheric pressure at ground level. Overpressures of 0.05 to 0.1 kPa (1 to 2 lbs per square ft [psf]) are produced by supersonic aircraft flying at normal operating altitudes. Some public reaction could be expected if individuals are exposed to sonic boom overpressures between 0.075 and 0.1 kPa (1.5 and 2 psf). The Space Shuttle, on landing approach at 18,000 m (60,000 ft) produces 0.0625 kPa (1.25 psf) at a speed of Mach 1.5 (DFRC 2006). Since they increase surrounding pressure levels, sonic booms are associated with structural damage in some areas. Table 4-27 lists common types of damage and the corresponding overpressure levels. For perspective, the overpressure associated with close lightning strikes may exceed 0.14 kPa (3.0 psf) (MSFC 1997b).

Table 4-27. Sonic Boom Damage to Structures

Sonic Boom Overpressure Nominal kPa (psf)	Type of Damage/ Item Affected	Extent of Damage
0.02 - 0.10 kPa (0.4 - 2 psf) Compares to piledriver at construction site	Cracks in plaster	Fine; extension of existing; more in ceilings; over door frames; between some plaster boards.
	Cracks in glass	Rarely shattered; either partial or extension of existing.
	Damage to roof	Slippage of existing loose tiles/slates; sometimes new cracking of old slates at nail hole.
	Damage to outside walls	Existing cracks in stucco extended.
	Bric-a-brac	Those carefully balanced or on edges can fall; fine glass (*e.g.,* large goblets) can fall and break.
	Other	Dust falls in chimneys.
0.10 - 0.20 kPa (2 – 4 psf) Compares to cap gun or firecracker near ear	Glass, plaster, roofs, ceilings	Failures show, which would have been difficult to forecast in terms of their existing localized condition. Nominally in good condition.
0.20 - 0.50 kPa (4 – 10 psf) Compares to handgun as heard at shooter's ear	Glass	Regular failures within a population of well-installed glass; industrial as well as domestic greenhouses.
	Plaster	Partial ceiling collapse of good plaster; complete collapse of very new, incompletely cured, or very old plaster.
	Roofs	High probability rate of failure for tile roofs in nominally good state; some chance of failures in tiles on modern roofs; light roofs (bungalow) or large area can move bodily.
	Walls (out)	Old, free standing, in fairly good condition can collapse.
	Walls (in)	Inside ("Party") walls known to move at 10 psf.
> 0.50 kPa (> 10 psf) Compares to fireworks display from viewing stand	Glass	Some good glass will fail regularly. Glass with existing faults could shatter and fly. Large window frames move.
	Plaster	Most plaster affected.
	Ceilings	Plaster boards displaced by nail popping.
	Roofs	Most slate/slurry roofs affected, some badly; large roofs having good tile can be affected; some roofs bodily displaced causing gale-end; domestic chimneys dislodged if not in good condition.
	Walls	Internal party walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage.
	Bric-a-brac	Some nominally secure items can fall (*e.g.,* large pictures), especially if fixed to party walls.

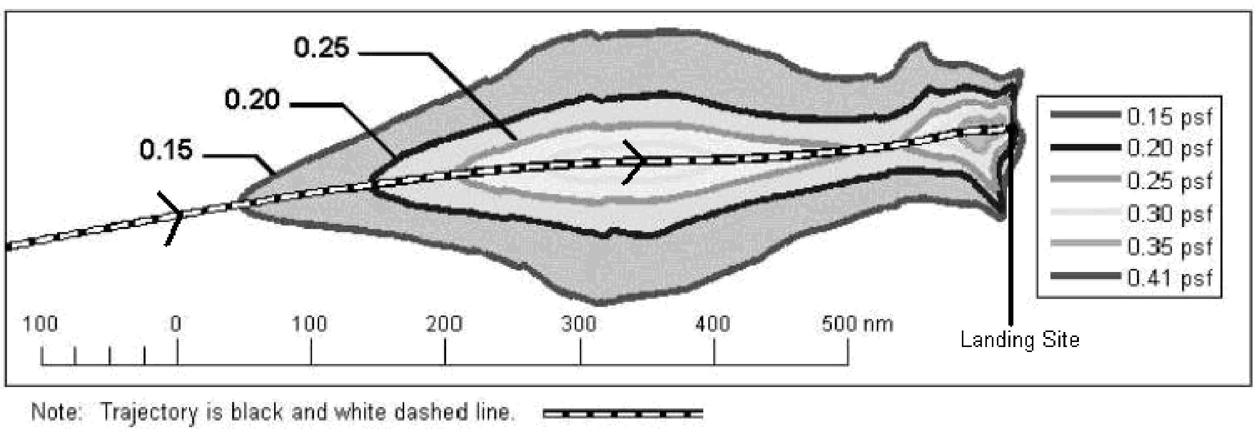
Source: MSFC 1997b

NASA performed extensive sonic boom atmospheric entry modeling for the X-33 reusable launch vehicle program (MSFC 1997b) which addressed the environmental impacts associated with a number of potential western U.S. landing sites. In addition, NASA has performed preliminary sonic boom footprint analysis for the Orion spacecraft (JSC 2007e).

Future NEPA documentation for Orion terrestrial landing site(s) would address sonic boom overpressure levels and their effects in greater detail.

4.1.4.1.2 Preliminary Results for Orion Earth Atmospheric Entry

NASA has performed preliminary evaluations of the potential sonic boom footprints for atmospheric entry of the Crew Module over the western continental U.S. (the returning Service Module would also create a sonic boom footprint, which would occur over the Pacific Ocean, which is discussed in Section 4.1.4.2.1). Preliminary results of the Crew Module analyses indicate peak overpressure values ranging from 0.016 to 0.021 kPa (0.33 to 0.43 psf) occurring approximately 11 to 31 km (7 to 22 mi) from a landing site (JSC 2007e). Figure 4-12 shows the preliminary projected sonic boom footprint for the Crew Module returning from a lunar mission along a representative trajectory.



Note: See conversion table on page xxiii for English and metric units Source: JSC 2007e

Figure 4-12. Projected Crew Module Descent Sonic Boom Overpressure Contours

The contours are the peak ground overpressures due to a sonic boom. The landing site is represented by a small black circle on the far right side of the trajectory line. The outermost contour is 0.007 kPa (0.15 psf) (JSC 2007e). As a comparison, the Space Shuttle mission STS-26 entry in 1988 was measured to have a maximum overpressure value of 0.11 kPa (2.3 psf) (JSC 2007j). The maximum overpressure calculated for each of the Crew Module entry trajectories remained well below the Space Shuttle maximum overpressure and below levels at which minor structural damage or community complaints would be expected. Based on this study, the environmental impacts, including those to marine species, from the Crew Module entry sonic booms would be expected to be negligible.

As a normal part of the Constellation Program design process, recent discussions indicate that the magnitudes of the overpressures could be somewhat higher than what is presented above.

However, the overall conclusion remains unchanged that the overpressures produced by the Crew Module during entry would be lower than those produced by the Space Shuttle. This is an expected result as the Crew Module is a smaller and lighter weight vehicle than the Space Shuttle. Future analyses are planned to refine these estimates.

Earth Atmospheric Entry Accidents

If the Crew Module were to have a catastrophic failure during atmospheric entry, the primary hazard would be that of falling debris. For the Space Shuttle Program, JSC Range Safety uses models developed after the Space Shuttle *Columbia* accident to predict atmospheric entry hazards to the public. These models calculate the risk of casualty resulting from falling debris. The Space Shuttle's trajectory is sometimes modified as the mission nears its completion if the upcoming landing opportunities have a predicted collective public risk of casualty due to falling debris that exceeds acceptable limits. This approach takes into account the probability of a catastrophic failure, the size of the resultant debris field, the resultant amount of debris that would survive to ground impact, the distribution of harmful debris within the debris field, population distribution on the ground, and population sheltering.

For the Constellation Program, preliminary analyses of the risk of potential debris falling on the public while the Orion Crew Module is en route to the landing site have been initiated. The analyses used models developed for and validated by the Space Shuttle Program. The results of these analyses indicate that, regardless of the terrestrial landing sites selected, the Constellation Program is expected to meet NASA's NPR 8715.5 criteria for risk to the public, and would not require in-flight orbital adjustments to meet those criteria. These results were anticipated since, compared to the Space Shuttle, the Crew Module is a smaller and a simpler vehicle that is planned to have a higher overall probability of successful mission completion. In addition, the Crew Module should have far fewer potential debris pieces in the unlikely event of a catastrophic atmospheric entry failure. Furthermore, in the nearly 50-year history of human spaceflight (U.S.: Mercury, Gemini, and Apollo; Russia: Soyuz; and China: Shenzhou), there have been no capsule breakups upon atmospheric entry.

Crew Module failure in the immediate vicinity of the landing site would result in impact of Crew Module debris in the designated landing zone. Therefore, the risk to the public associated with debris would be expected to be negligible.

NASA will coordinate with the FAA regarding atmospheric entry options so that aircraft could be moved from potential debris hazard zones in the event of an anomalous atmospheric entry. NASA will continue to assess whether any other hazards, such as toxic chemical and propellant releases, would be significant should the Crew Module make an uncontrolled impact in the landing zone. If such hazards are found to be significant, NASA would take appropriate risk mitigation measures, *e.g.*, changing the day of landing for weather considerations, movement of personnel, or selection of an alternative landing site.

4.1.4.2 Impacts of Service Module and Docking Mechanism Jettison and Crew Module Landing in the Pacific Ocean

4.1.4.2.1 Ocean Disposal of the Service Module and Docking Mechanism

The Service Module and the docking mechanism (from an International Space Station mission) would be jettisoned from the Orion spacecraft over a predetermined area of the Pacific Ocean just prior to atmospheric entry. See Section 4.1.3.1 for additional information. These objects would not be expected to survive atmospheric entry intact, but would break into many pieces of debris, some of which would survive to ocean impact. In accordance with NPR 8715.6 "NASA Procedural Requirements for Limiting Orbital Debris Generation" (NASA 2007d) and NASA Safety Standard 1740.14 "Guidelines and Assessment Procedures for Limiting Orbital Debris" (NASA 1995c), this disposal would be carried out such that the resulting debris field boundaries are no closer than 370 km (230 mi) from foreign land masses, 46 km (29 mi) from U.S. territories and the Continental United States, and 46 km (29 mi) from the permanent ice pack of Antarctica. Impact of the Service Module (and of the docking mechanism for International Space Station missions) would generate a debris field in a targeted area of the Pacific Ocean. A number of considerations go into the selection of the targeted area. These factors include technical considerations, such as orbital mechanics, and safety, environmental, and geopolitical considerations.

The environmental impacts associated with return of the Service Module include the immediate impacts of the entry sonic booms; the potential for debris striking people, ships, or wildlife; and the potential longer-term impacts of the debris on the ocean environment. The environmental impact of fragments of the Service Module (and the docking mechanism for International Space Station missions) falling into the Pacific Ocean would depend on the physical properties of the materials (*e.g.*, size, composition, quantity, and solubility) and the marine environment of the impact region. Sonic boom footprints for atmospheric entry of large and small pieces of Service Module debris and the associated environmental impacts would be similar to that discussed for the Crew Module.

NASA risk management practices would ensure that the debris impact footprint is selected so that the potential risks to aircraft and shipping from Service Module debris is very small. NASA will know prior to atmospheric entry when and where the debris field will be, and will ensure that NOTAMs and Notices to Mariners are disseminated in a timely manner. NASA will continue to focus on falling debris as the primary hazard and will compute risk estimates based on aircraft and ship traffic given the release of such notices and expected deviation from normal aircraft and shipping routes.

The potential environmental impacts of debris within the expected debris field would be expected to be small. The activities most likely to be affected would be trans-oceanic surface shipping and commercial airline routes. Debris would not be a risk to shipping or the environment whether the debris sinks, floats, or washes ashore. Surviving pieces of debris could be lethal if they strike a living organism on or near the ocean surface. Some surviving pieces could have sufficient kinetic energy to potentially cause damage to ships. Once the pieces travel a few feet below the ocean surface, their velocity would be slowed to the point that the potential for direct impact on sea life would be low. Even if there were a large ship within the impact area, the probability of hitting it with one or more pieces of debris would be small (NASA 1996).

The potential for long-term environmental impact on the debris on the ocean floor is small. The Service Module would be constructed mostly of carbon-based composites and aluminum. Propellant in the Service Module, including hydrazine, would be expected to vent fully prior to debris impact but trace amounts could remain. The propellant tanks would be expected to lose their integrity (*i.e.*, become breached) during atmospheric entry or at impact, ensuring that only residual hydrazine would remain, which would be diluted by seawater and therefore would not be expected to significantly affect marine life.

Based on past analyses of other space components, it is expected that the environmental impact of atmospheric entry debris would be negligible (NASA 1996, USAF 1998, NASA 2005b, NASA 2006d). It is expected that most components would sink and slowly corrode on the ocean floor. Toxic concentrations of metals would be unlikely because of slow corrosion rates and the large volume of ocean water available for dilution (USAF 1996, NASA 2006d).

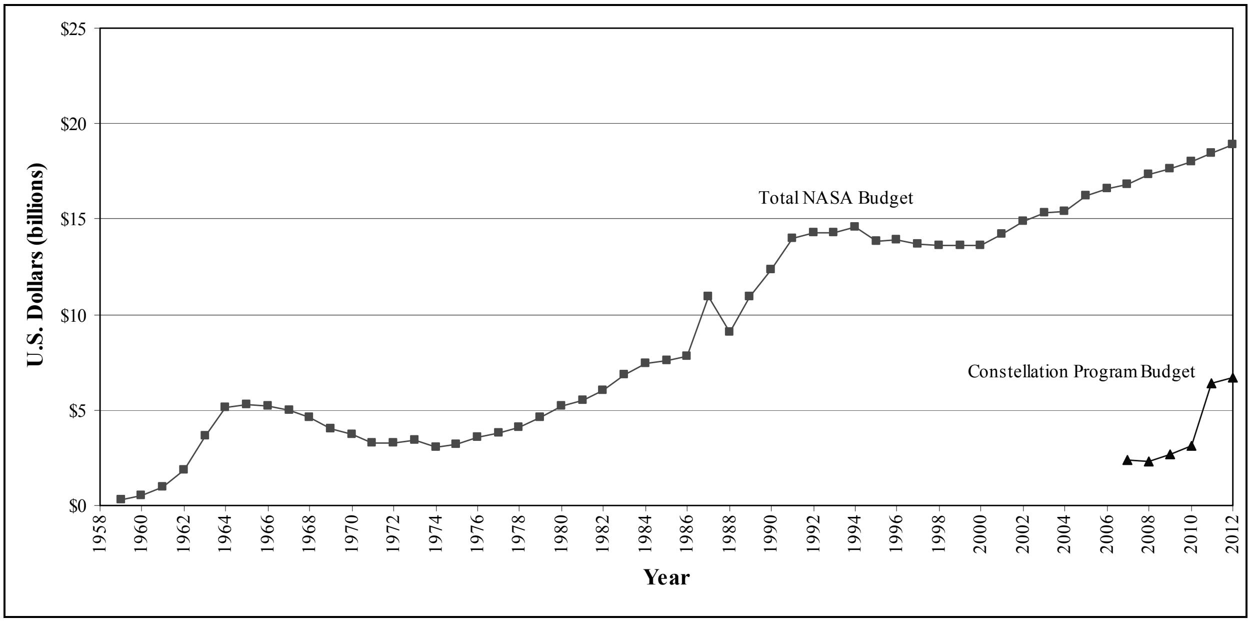
4.1.4.2.2 Ocean landing of the Orion Crew Module

The environmental impacts of the splash down of the Crew Module returning from either the International Space Station or a lunar mission would be expected to be very small. In addition to recovering the crew and the Crew Module, the recovery team would remove materials from the vehicle that need to be transported separately (*e.g.*, returned lunar samples, payloads, and health monitoring devices) from the Crew Module. In addition, residual fuel (methane/oxygen bipropellant) would remain in the Crew Module and would have to be properly managed during recovery operations. The recovery of the Crew Module is expected to have a similar environmental impact to the Pacific Ocean as the recovery of the Ares I First Stage or the Ares V SRBs has to the Atlantic Ocean (see Section 4.1.3.1). The Constellation Program is currently studying the possibility of substituting the methane/oxygen bipropellant with a monopropellant (*e.g.*, hydrazine).

Although NASA would work to ensure that the environmental impacts of an ocean landing of the Crew Module would be low, several aspects of the environmental impacts are still being evaluated. Since potential ocean landing sites would not be selected until much later, the specific environmental impacts at any particular site cannot be determined. Similarly, the detailed environmental impacts of ship operations to recover the Crew Module cannot be estimated without knowledge of the landing site and home port. Although these details are not known, past operations for the Apollo Program and similar operations with the Space Shuttle Program, in the case of Ares I First Stage or the Ares V SRB retrieval, indicate that NASA can manage these activities with minimal environmental impacts. NASA will coordinate with the FAA regarding atmospheric entry options so that aircraft could be moved from potential debris hazard zones in the event of an anomalous atmospheric entry.

4.1.5 Potential Socioeconomic Impacts of Implementing the Constellation Program

NASA's past, current, and projected activities have resulted in beneficial impacts to local, regional, and national economies. Over the past 50 years, NASA has expended billions of dollars in support of a wide array of programs across multiple NASA Centers throughout the United States. The economic benefits associated with NASA's continued commitment to the Nation's leadership in space and aeronautics research are expected to continue through 2012 and beyond (reported as nominal U.S. Dollar values, not adjusted for inflation) (see Figure 4-13).



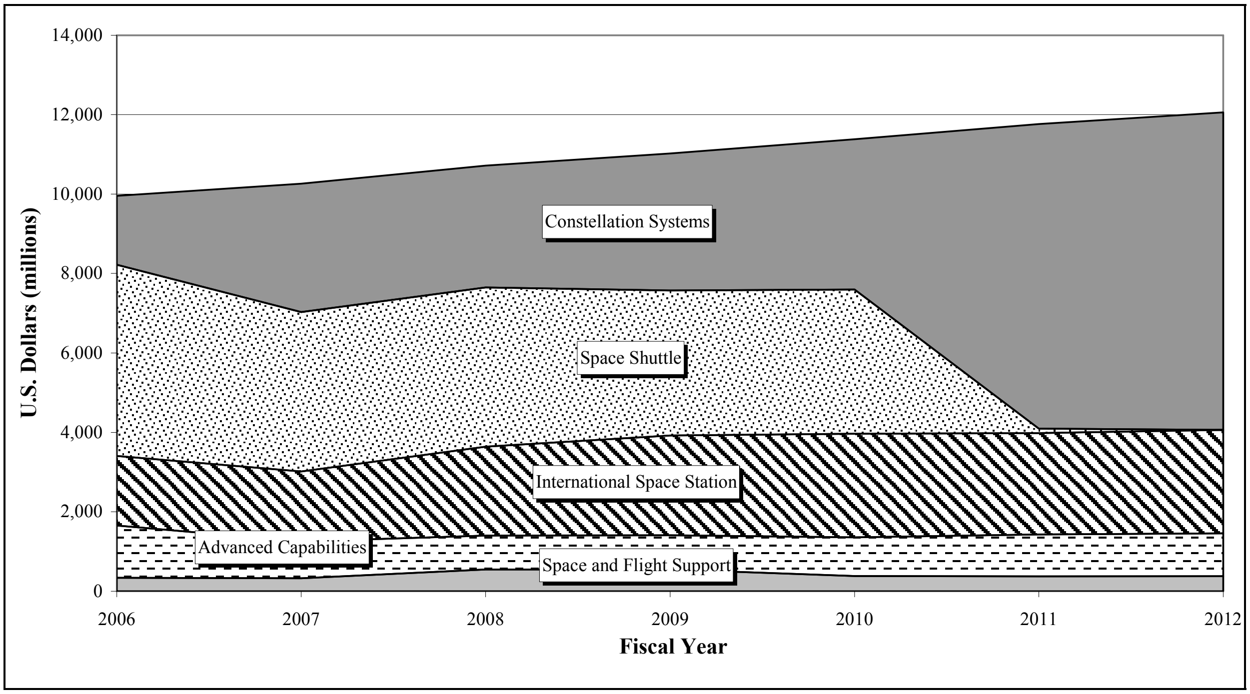
Sources: JSC 2007c, NASA 2006a, and NASA 2005a

Figure 4-13. Total NASA Budget Fiscal Years 1959-2012 and Constellation Program Budget

The President's fiscal year 2008 budget request reflects a commitment by NASA to continue the investments begun in prior years.

The distribution of work related to the proposed Constellation Program across NASA's Centers reflects NASA's intention to productively use personnel, facilities, and resources from across the Agency to accomplish NASA's exploration initiative (see Figure 2-2). Assignments align the work to be performed with the capabilities of the individual NASA Centers. The diversity of projects to be performed at each NASA Center would vary considerably; however, it is NASA's intent to retain a major socioeconomic footprint at each Center.

The proposed implementation of the Constellation Program, including the initial investment required and costs of future operations, together with other NASA programs, would be supported within NASA's long-term budget plan (see Figure 4-14). The Constellation Program would not be expected to produce any significant changes in NASA's civil servant workforce at the various NASA Centers. However, detailed analyses of the socioeconomic impacts of implementing the Constellation Program and the consequent significant conclusions are limited by the fact that the Constellation Program is at an early stage of development and would be subject to adjustments and changes as Program requirements become better defined. Detailed meaningful estimates of the specific work allocations at each Center would be available once the prime contracts are awarded for all of the Program's major projects and procurements. Quantification of impacts would require detailed cost information both from the Federal and private sectors and thorough economic analyses of the data, most of which is currently unavailable. The unpredictability of contractor funding and asset allocations at this time limits the projection of effects at each NASA Center.



Source: Adapted from NASA 2007b

Figure 4-14. NASA Fiscal Year 2008 Budget Request for Exploration Systems and Space Operations

NASA recognizes that through 2012 the Human Spaceflight Program will be in transition as certain NASA Programs, such as the Space Shuttle Program, are phased out. NASA is currently beginning the process of transitioning the workforce, infrastructure, and equipment from the Space Shuttle Program to the Constellation Program. It is anticipated that many civil servants and support contractors at the various NASA Centers would transition to Constellation Program activities during this transition. NASA is committed to a strategy to maintain current civil servant workforce levels, to the extent practicable, and provide funding to preserve the critical and unique capabilities provided by each NASA Center.

4.1.6 Potential Environmental Impacts to the Global Environment

4.1.6.1 Launch Vehicle Impacts on Stratospheric Ozone

Exhaust emissions from the Ares I First Stage and the Ares V SRBs would release reactive chlorine compounds (HCl, Cl, Cl_2, and ClO) and particulate matter (Al_2O_3 and aluminum hydroxychloride) into the stratosphere at high temperatures. Figure 3-25 provides a graphic of the atmospheric layers and their estimated altitudes. Without being consumed, the chlorine compounds break down the stratospheric ozone (O_3) and remain in the stratosphere as long as two to three years. The particulate matter also acts as a catalyst for ozone destruction, with high temperatures from the exhaust often accelerating the destruction.

Previous work cites the ozone destruction by liquid propellants and oxides of nitrogen (NO_x) produced in aircraft afterburning as insignificant compared to the destruction by chlorine and particulate matter emissions from ignition of solid fuel (TRW 1999). Previous studies have shown that little launch exhaust released in the troposphere actually penetrates into the stratosphere and can be considered negligible compared to that generated in the stratosphere.

The effects of emissions introduced into the stratosphere would depend on the launch profile (*i.e.*, ascent angle) and the rate that propellant is consumed within the stratosphere. Because this Final PEIS is being prepared well in advance of Ares test or mission launches, assumptions were made that the Ares I and Ares V launch profiles would be similar to those for the Space Shuttle. Solid propellant consumption would occur just over two minutes after launch with Ares I First Stage and Ares V SRB separation occurring at an altitude of approximately 58 km (36 mi) and 39 km (24 mi), respectively, depending on launch profile and mission. The Space Shuttle SRB propellants are consumed in approximately two minutes after launch with separation occurring at an altitude of approximately 49 km (30 mi). The Space Shuttle SRB propellant consumption rates as a function of altitude are approximately equal to the expected Ares I and Ares V propellant consumption rates. Therefore, the rate of release of emissions into the stratosphere from the Ares I and Ares V were calculated as the product of the Space Shuttle emission release rate and the ratio of the Ares solid propellant mass consumed per unit time to that calculated for the Space Shuttle.

The Space Shuttle chlorine release rate is estimated as 3.9 mt (4.3 tons) per vertical kilometer, and the Ares I and Ares V vehicles are designed to use 62.5 and 125 percent, respectively, of the solid propellant used by the Space Shuttle. Therefore, the Ares I and Ares V vehicles are estimated to release 2.4 and 4.9 mt (2.7 and 5.4 tons), respectively, of chlorine per vertical kilometer in a single launch. Since a single launch of the Space Shuttle releases 71.6 mt (79 tons) of chlorine to the stratosphere and 102 mt (112 tons) of particulate matter (USAF 2000), each launch of an Ares I and an Ares V would release approximately 45 and 90 mt (50 and 99 tons) of chlorine, respectively and 63.5 and 127 mt (70 and 140 tons) of particulate matter, respectively, to the stratosphere.

Based on the solid rocket engine tests and flights proposed in Table 2-11 for the Constellation Program, seven Ares I test launches are planned over the 2009 to 2014 timeframe, and up to five Ares I mission launches per year are planned between 2015 to 2020, although the actual number of launches could be lower. In addition, five Ares V launches are planned between 2018 and 2020. Estimated total chlorine and particulate matter emissions to the stratosphere from these launches would be no more than 2,200 and 3,000 mt (2,400 and 3,400 tons), respectively, over that period.

During a rocket launch, there are both short-term and long-term cumulative effects on stratospheric ozone. The short-term effect is the creation of a local hole in the ozone layer, but stratospheric mixing has been observed to close the hole within a few hours for Space Shuttle launches. Table 4-28 provides the predicted ozone hole size and depletion time at an altitude of 20 km (12 mi) for various launch vehicles that utilize solid rocket motors during ascent.

However, earlier in situ measurements and modeling studies of a Titan IV launch indicated that local ozone concentrations did not return to pre-launch conditions for as long as 83 minutes (TRW 1999).

Table 4-28. Ozone Depletion Time and Hole Size

Launch Vehicle	Chlorine Release Rate (tons/km)*	Hole Diameter (km) at Altitude of 20 km*	Hole Duration (minutes)
Space Shuttle	4.3	5	97
Titan IV	2.0	4	25
Atlas V 551/552	0.65	2	3.6
Delta IV M+ (5,4)	0.36	3	1.3
Delta IV M+	0.42	2	1.0
Atlas II AS	0.10	0.8	0.1
Delta II	0.30	1	0.9

*See conversion table on page xxiii for English and metric units Source: USAF 2000

Table 4-28 shows that increased chlorine release rates tend to yield larger local holes in the ozone layer that persist for longer times. The relative persistence of the local ozone hole (an indicator of the increased radiation at the Earth's surface) can be approximated by the area of the hole multiplied by the time that the hole persists. The data from Table 4-28 are plotted in Figure 4-15 in terms of the product of hole diameter and hole duration (persistence) and extrapolated, to estimate the impacts from both Ares I and Ares V launch vehicles.

Persistence of the local ozone hole for Ares I would be 35 percent of that from the Space Shuttle, while the local ozone hole for Ares V would have 60 percent greater persistence than for Space Shuttle launches. Because the flight trajectories of launch vehicles are not vertical and wind shears would occur, the ground level ultraviolet radiation increase from loss of stratospheric ozone would be less than would be the case if the ozone depletion occurred in a uniform vertical column. Thus, temporary ozone holes due to rocket exhausts have been judged by experts (Jackman 1998) to have an insignificant impact to global ozone.

Simulations that assumed nine Space Shuttle launches and three Titan IV launches each year for 20 years were conducted previously (Jackman 1998). Assuming stratospheric emissions of 62 and 34 mt (68 and 38 tons) of HCl per Space Shuttle and Titan IV launch, respectively, the calculated total HCl releases over 20 years were 13,154 mt (14,500 tons), equating to a 0.023 percent decrease in annually averaged global total ozone levels as compared to no launches. Similarly, projected stratospheric emissions of 102 and 63 mt (112 and 69 tons) of Al_2O_3 per Space Shuttle and Titan IV launch, respectively, totaled to 22,045 mt (24,300 tons) of Al_2O_3 releases over 20 years, equating to a 0.010 percent decrease in annually averaged global ozone levels as compared to no launches. The total collective calculated impact from HCl and Al_2O_3 releases over 20 years was a 0.033 percent decrease in annually averaged global ozone levels.

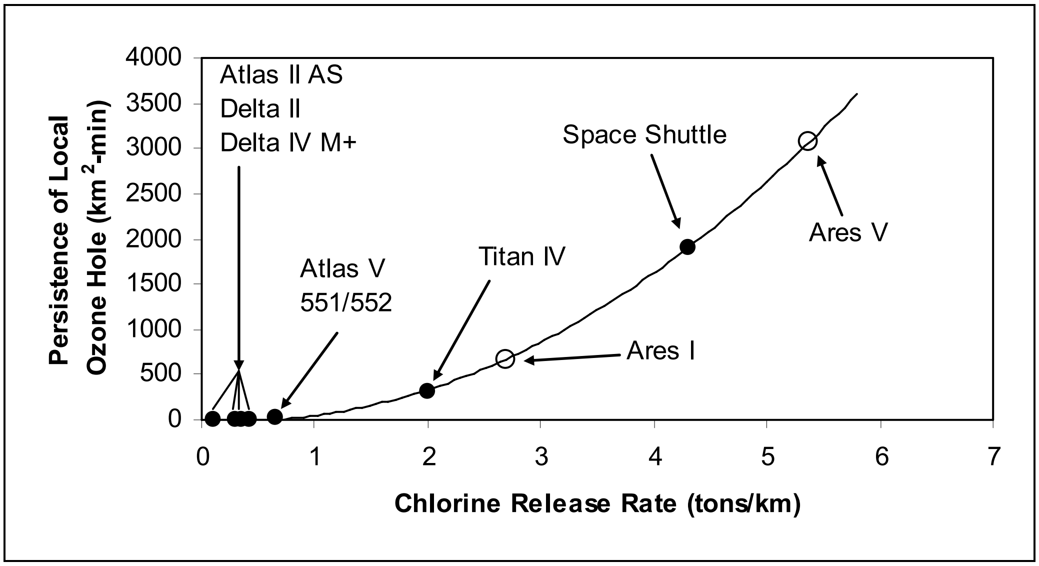


Figure 4-15. Ozone Hole Persistence for Various Launch Vehicles

The Constellation Program entails fewer projected launches through the early 2020s than this simulation. Based on the ratio of solid propellant masses between the Ares and Space Shuttle launch vehicles, each launch of an Ares I and an Ares V would release 45 and 90 mt (50 and 99 tons) of chlorine, respectively, and 64 and 130 mt (70 and 140 tons) of particulate matter, respectively, into the stratosphere. This totals to an estimated stratospheric release of 2,200 mt (2,400 tons) of HCl and 3,000 mt (3,400 tons) of Al_2O_3 at most through the early 2020s. Assuming a direct relationship between stratospheric releases and annually averaged global ozone level changes, the expected annually averaged global ozone level reductions from Constellation stratospheric HCl and Al_2O_3 releases would be no more than 0.0038 percent and 0.0014 percent, respectively, or a total of 0.0051 percent. However, the actual Constellation Program launch rates would most likely be lower than those projected in the simulations; therefore, the impact on the stratosphere from the Constellation Program would be lower.

4.1.6.2 Potential Impacts of the Constellation Program on Global Climate Change

Greenhouse gases absorb the radiative energy from the Sun and the Earth. Some direct greenhouse gases (*e.g.*, carbon dioxide, chlorofluorocarbons, and water) are emitted from processes described in this Final PEIS, and other gases (*e.g.*, NO_x and VOCs) emitted from these processes contribute indirectly by forming ozone and other reactive species that photochemically react with the greenhouse gases and control the radiation penetrating to the troposphere.

The following annual greenhouse gas emissions were reported for 2004 in the U.S.: 7.07×10^9 mt (7.8×10^9 tons) of carbon dioxide (CO_2) equivalent, 1.71×10^7 mt (1.88×10^7 tons) of NO_x, and 8.76×10^7 mt (9.66×10^7 tons) of CO (EPA 2006a). Although water vapor is considered a greenhouse gas, it is not tracked in the EPA inventory.

The principal source of carbon emissions that would be associated with the Constellation Program would be from NASA's energy use in support of the program. From fiscal year 1990 through fiscal year 2005, NASA reduced its total annual primary energy consumption by about

16 percent, from approximately 2.95×10^{16} Joules (J) (28,000 billion British Thermal Units [Btu]) to approximately 2.53×10^{16} J (24,000 billion Btu) (DOE 2006). NASA consumed energy primarily across four end-use sectors: 1) standard buildings; 2) industrial, laboratory and other energy intensive facilities; 3) exempt facilities and 4) vehicles and equipment, including aircraft operations (see Table 4-29).

Table 4-29. NASA Energy Use

End Use	Fiscal Year 1990 Consumption (Billion Btu)[1]	Fiscal Year 2005 Consumption (Billion Btu)[1]	Percent Change
Standard Buildings	10,764.0	10,793.8	+ 0.3%
Energy Intensive Facilities	10,190.2	7,273.4	- 28.6%
Exempt Facilities[2]	6,050.7	4,891.6	- 19.1%
Vehicles & Equipment	1,736.7	1,058.1	- 39.1%
Total Primary Energy	28,741.6	24,016.9	- 16.4%

Source: DOE 2006

Notes:

1. See conversion table on page xxiii for metric conversion
2. Predominantly buildings and facilities in which it is technically infeasible to implement energy efficiency measures or where conventional performance measures are rendered meaningless by an overwhelming proportion of process-dedicated energy

The U.S. Department of Energy (DOE) reported that NASA also reduced estimated carbon emissions from facility energy use in standard buildings and energy intensive facilities from about 2.9×10^5 mt (3.2×10^5 tons) in fiscal year 1990 to 2.5×10^5 mt (2.8×10^5 tons) of carbon equivalent in fiscal year 2005, a 14 percent reduction. Although not reported by DOE, NASA's reduced energy usage in exempt facilities, vehicles and equipment would also have resulted in proportional reductions in carbon emissions.

Cumulative global impact from energy use under the Constellation Program would be expected to be similar to that from historical energy use under the Space Shuttle Program. It is NASA's policy to fully comply with the requirements of the National Energy Conservation Policy Act, Executive Order (EO) 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, and other statutory and Presidential directives regarding energy efficiency. NASA strives to reduce energy consumption and cost whenever possible in all facility operations. Each NASA Center and Component Facility has an established energy efficiency program directed at reducing facility energy intensity and associated greenhouse gas emissions as well as expanding the use of renewable energy for facilities and operational activities.

Emissions from rocket exhaust would also deposit carbon into the atmosphere. Based on the solid rocket engine tests and flights identified in Table 2-11, over the 2009 to 2020 timeframe roughly 33,900 mt (37,300 tons) of PBAN solid propellant would be expected to be used for engine testing, Launch Abort System testing, and launches. The emissions percentages from these activities, by weight, would be approximately 24 percent CO, 3.5 percent CO_2, and 9.5 percent water (MSFC 1989). In addition, the proposed 100 Upper Stage engine tests (at simulated altitude) at SSC would produce about 3,200 mt (3,500 tons) of CO during the development period. The Constellation Program's cumulative contribution to global warming from CO_2 and CO rocket exhaust emissions would therefore not be expected to exceed 1,200 mt (1,300 tons) CO_2 equivalent and 11,000 mt (12,000 tons) CO equivalent over the 2009 to 2020 timeframe, much smaller than NASA's contribution from energy consumption or than the 2004 national emissions levels.

Under the Proposed Action, NASA has assumed that HCFC 141b would not be used to produce foam insulation for the LH/LOX tanks for the Ares I and Ares V vehicles. To comply with EPA requirements to phase out ODS, and to reduce the long-term supportability risk posed by ODS usage, NASA intends to develop cryoinsulation replacements for the Ares I Upper Stage that do not contain HCFC 141b. NASA might continue to use relatively small amounts of HCFC 141b-blown foam for use in comparative studies. In addition, ATK also uses small quantities of HCFC 141b in foam used to fill test holes in foam insulation on the exterior surface of solid rocket motors. ATK is currently working with NASA to determine the requirements for the Ares I First Stage. The current rate of use is 12 kg/year (26 lb/yr) (ATK 2006). NASA is currently examining possible alternatives to HCFC 141b.

The global warming potentials for many greenhouse gases (expressed in metric tons of CO_2 equivalent) have been developed to allow comparisons of heat trapping in the atmosphere. The global warming potentials of HCFC 141b reported by the EPA range from 630 to 713 g (22 to 25 oz) CO_2 equivalent per gram of HCFC 141b (EPA 2006d). Therefore, assuming that NASA's annual Constellation Program use of HCFC 141b is less than 100 kg (220 lbs) per year, the maximum annual global warming potential from foam blowing operations is equivalent to less than 100 mt (110 tons) of CO_2, a very small fraction of annual U.S. CO_2 emissions.

Thus, the total global warming potential from NASA activities is approximately 2.5×10^5 mt (2.8×10^5 tons) carbon-equivalent from energy consumption, less than 100 mt (110 tons) CO_2 equivalent annually from foam blowing and, over the 2009 to 2020 timeframe, no more than 1,200 mt (1,300 tons) CO_2 from rocket exhaust as well as 11,000 mt (12,000 tons) of CO from rocket exhaust and rocket testing. Collectively, these are less than 0.004 percent of the total global warming potential from all annual U.S. carbon emissions.

4.2 ENVIRONMENTAL IMPACTS OF THE NO ACTION ALTERNATIVE

Under the No Action Alternative, the environmental impacts associated with implementing the Proposed Action would not occur. Specifically, no direct impacts associated with launch vehicle engine tests, launches, atmospheric entry, wind tunnel tests, construction of new facilities, modifications of existing facilities, and other direct actions connected with the Constellation Program would occur. This would result in less noise and contamination of air, water, and soil in the near-term. In addition, the secondary impacts associated with the workforce supporting the Proposed Action would not occur. These impacts relate to the support infrastructure (*e.g.*, structures, utilities and roads) and include waste, water impacts, noise and air emissions, as well as the socioeconomic impacts of the workforce on the surrounding communities and region. In addition, needed facility maintenance which would be funded by the Constellation Program may not be performed. Therefore, many of these facilities which have historic status could be placed under consideration for demolition; thus, constituting an adverse effect on historic properties.

As this time, a prediction cannot be made as to how the President or Congress would redirect funding and personnel that would otherwise support the proposed Constellation Program. As indicated earlier, the President has directed NASA to terminate the Space Shuttle Program no later than 2010. Without new programs and projects to fill the void left by the close of the Space Shuttle Program, substantial adverse socioeconomic impacts would be experienced by localities that host NASA Centers heavily involved in the Space Shuttle Program.

At each Center or site considered under the Proposed Action, the environmental impacts of the No Action Alternative would vary somewhat. At KSC, the additional rocket launches of the development vehicles, mission launches, and the resulting noise and exhaust clouds from the Ares launches would not occur, along with the direct near-pad impacts from heat, exhaust, and noise on close-in vegetation and wildlife. No sound suppression system water discharges following Ares launches would occur. Planned near-term modifications to the VAB, Mission Control Center and LC-39 Pad B to accommodate Ares I test flights, evaluated under the *Final Environmental Assessment for the Construction, Modification, and Operation of Three Facilities in Support of the Constellation Program, John F. Kennedy Space Center, Florida* (KSC 2007f), and the supporting infrastructure necessary to support Ares mission launches would not be necessary.

At SSC, the additional full-scale J-2X engine tests planned to support the Constellation Program would not occur. As a direct result, modifications to the existing facilities and the construction of a new test stand (A-3) evaluated in the *Final Environmental Assessment for the Construction and Operation of the Constellation Program A-3 Test Stand, John C. Stennis Space Center, Hancock County, Mississippi* would not be necessary. In addition, the noise and water vapor exhaust clouds from Constellation Program engine tests would not occur. Cooling water discharges from Program-related engine tests (and the subsequent thermal impacts) would not occur.

At JSC, the impacts associated with modifications of facilities necessary to support the Proposed Action would not occur. There would be no aviation-related training operations for the Constellation Program at the Ellington Field Facility.

At MSFC, the impacts associated with modifications of facilities necessary to support the Proposed Action would not occur. Additional rocket engine tests planned to support the Constellation Program would not be necessary. As a direct result, any modifications to the test facilities to support engine development tests would not occur, nor would noise and water vapor exhaust clouds from Constellation Program engine tests. Cooling water discharges from Constellation Program-related engine tests (and subsequent thermal impacts) would not occur.

At GRC PBS, the impacts of modifications of facilities necessary to support the Proposed Action and impacts from engine testing would not occur.

At LaRC, the impacts associated with modifications and operation of test facilities and wind tunnels necessary to support the Proposed Action would not occur. The NRHP-eligible and NHL historic properties would not undergo modifications, alterations, or additions in support of Constellation Program activities. However, the Impact Dynamics Facility (Gantry) (Building 1297), a National Historic Landmark, was previously considered for possible demolition. If the Proposed Action is not implemented, NASA may have to consult with the Virginia SHPO regarding demolition of the Gantry, which would constitute an adverse effect.

At ARC, the impacts associated with modifications of facilities necessary to support the Proposed Action would not occur.

At WSTF and WSMR, the impacts of construction and modifications of facilities necessary to support the Proposed Action would not occur. The near-term modifications to the launch pad evaluated in the *Final Environmental Assessment for the NASA Launch Abort System (LAS) Test Program, NASA Johnson Space Center White Sands Test Facility, Las Cruces, New Mexico* (WSTF 2007b) would not be necessary. The direct and indirect impacts of engine development test activities, including the Launch Abort System test program at WSTF and the short-term noise and air emissions associated with the rocket launches at the WSMR in support of the Launch Abort System, would not occur.

At ATK, the additional full-scale five-segment solid rocket motor tests planned to support the Constellation Program would not occur. As a direct result, modifications to the test facilities to support this activity would not be necessary. In addition, the noise and exhaust clouds from solid rocket motor tests in support of the Constellation Program would not occur.

There would be no terrestrial or water (ocean) landings of the Orion Crew Module under the No Action Alternative. Therefore, there would be no environmental impacts associated with preparing the terrestrial landing site(s), landing of the Crew Module, or recovery of the Crew Module, Ares I First Stage, and Ares V SRBs. There would be no risks to public from overflight of the Crew Module and no disposal of launch vehicle stages and other vehicle elements in the Atlantic, Pacific, and Indian Oceans.

In addition, no Environmental Justice impacts would be anticipated at any of the facilities proposed for use by the Constellation Program.

4.3 CUMULATIVE IMPACTS

This section addresses the cumulative impacts of implementing the Proposed Action coupled with other past, present, or reasonably foreseeable activities that might collectively result in potentially significant environmental impacts. Cumulative impacts are the impacts on the environment that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant, activities that take place within the same period of time and/or within the same geographical area.

The principal activities associated with the Proposed Action that would result in potential environmental impacts include rocket engine tests, rocket launches, construction of new facilities, modifications of existing facilities, and other direct actions. In addition, there may be secondary impacts associated with the support infrastructure (*e.g.*, structures, utilities, and roads). Such secondary impacts could include wastes, impacts to water, noise, and air emissions, as well as the socioeconomic impacts of the workforce on the surrounding communities and region. The potential socioeconomic impacts of implementing the Constellation Program were discussed previously in Section 4.1.5.

Since the proposed Constellation Program would be largely built upon the ongoing Space Shuttle Program, including the technologies and facilities at each of the potential sites that would have Constellation Program-related activities, the potential environmental impacts would be expected to be very similar to the current impacts associated with the Space Shuttle Program. For sites which would be performing Constellation Program activities but did not or have not in recent years been performing similar activities under the Space Shuttle Program (*e.g.*, GRC), such activities would largely be similar to ongoing operations at those centers and therefore have similar environmental impacts.

For most of the sites, activities that would be undertaken under the Proposed Action would be expected initially to overlap with the Space Shuttle Program until the Space Shuttle is retired. However, the resulting environmental impacts of both the Space Shuttle Program and the Constellation Program would be expected to be small or negligible as the Constellation Program is in its early formulation stages. Actions that could have potential environmental impacts such as construction, engine testing, and test launches are in early planning stages and most construction would begin near the end of this decade, at the time of the planned Space Shuttle retirement. At most sites, the nature of the principal Constellation Program activities (engineering development, testing, research, and launch vehicle/spacecraft assembly) implies that the primary environmental impacts would be directly related to the size of the workforce (*e.g.*, waste, impacts to water, air emissions, and socioeconomic impacts).

Each NASA Center has multiple on-going programs that would be managed concurrently with the Constellation Program. It is reasonable to expect that these programs would conduct testing and evaluation activities and could engage in the construction or modification of buildings as needed. In addition, each NASA Center has funding plans which identify activities such as construction, demolition, or rehabilitation of buildings and test stands. Such activities would be evaluated for environmental impacts by the sponsoring program or affected Center(s) and would be subject to separate NEPA review and documentation, as appropriate. However, these activities may or may not occur within the given timeframe of the funding plan due to many factors (*e.g.*, implemented funding and program direction) and may or may not have any environmental impacts. NASA has identified categories of actions that have demonstrated no impact to the environment when implemented. In general, many on-going activities at NASA Centers fall into these categories of actions. For purposes of the cumulative impacts analysis, those Center activities that have no environmental impact are not discussed further.

4.3.1 Cumulative Localized Impacts

At KSC, launches of development vehicles and mission vehicles would release solid propellant combustion products, principally Al_2O_3 and HCl, to the atmosphere, and ultimately to the surrounding grounds and waters. While the highest concentrations would be within a few hundred meters of the launch pad, some of the exhaust cloud would ultimately deposit in the KSC/CCAFS region. These deposits would be in addition to similar deposits from past and anticipated future launches from KSC and CCAFS.

Over the period from 2009 to 2020, fewer than 48 five-segment solid rocket motors would be launched from KSC (see Table 2-11). Based on the emission factors developed for the *Environmental Impact Statement for the Space Shuttle Advanced Solid Rocket Motor Program* (MSFC 1989), the weight percent of emissions from burning PBAN propellant are 30 percent Al_2O_3, 24 percent CO, 3.5 percent CO_2, 21 percent HCl, 9.5 percent water, nine percent nitrogen, two percent hydrogen, and one percent other materials. Thus, the firing of five-segment solid rocket motors over this timeframe would produce no more than 9,100 mt (10,000 tons) of Al_2O_3, 7,300 mt (8,100 tons) of CO, 1,100 mt (1,200 tons) of CO_2, 6,400 mt (7,100 tons) of HCl, 2,900 mt (3,200 tons) of water, 2,700 mt (3,000 tons) of nitrogen, 610 mt (670 tons) of hydrogen, and 300 mt (340 tons) of other materials. Approximately two-thirds of the airborne emissions would be initially deposited in the local environment and troposphere, with the remainder deposited in the stratosphere.

These launches would be in addition to the launches from CCAFS. CCAFS launch pads would probably be sufficiently distant from LC-39 at KSC that the exhaust cloud impacts from those launches would only minimally affect the area in the immediate vicinity of LC-39. The possibility exists that exhaust clouds from CCAFS launch pads could reach some of the same far-field areas as Ares exhaust clouds would. This is not expected to be of a magnitude nor of a frequency that would substantially increase exhaust product deposition or result in substantial adverse impacts.

Various monitoring studies (AIAA 1993, CCAFS 1998, KSC 2003) have found that because of the nature of the soil in the area (high calcium carbonate), acid deposits from solid propellant exhaust clouds are quickly neutralized and the long-term effects of the HCl deposits are minimal. While each Ares launch would also have additional impacts very near the launch pad, these effects would be dominated by past and future launches on that pad and not by other nearby CCAFS launches.

Other near-pad launch impacts, including occasional noise impacts on wildlife from Ares launches, would primarily be localized and not compounded by future non-Constellation Program launches.

At SSC, the additional full-scale rocket engine tests planned to support the Constellation Program would result in a continuation of the occasional local impacts of engine tests, primarily short-term noise and water vapor exhaust clouds. The occasional loud noise from past and ongoing engine tests has not had a significant long-term impact on the local and regional area. The buffer area surrounding the site limits the noise impacts on humans and the noise impacts on wildlife in the buffer area are generally limited to startle responses. Furthermore, the proposed Constellation Program activities along with other foreseeable program activities at SSC would not be expected to result in a significant cumulative impact.

At MSFC, rocket engine tests planned to support the Constellation Program would result in a continuation of the occasional local impacts of engine tests, primarily short-term noise and water vapor exhaust clouds. The occasional loud noise from past and ongoing engine tests has not had a significant long-term impact on the local and regional area. MSFC has strategies to mitigate potential adverse impacts such as noise from engine testing (see Chapter 5). Furthermore, the proposed Constellation Program activities along with other foreseeable program activities at MSFC would not be expected to result in a significant cumulative impact.

At WSMR, Launch Abort System test launches would result in the addition of noise and exhaust particulates. The additional noise associated with the test launches would be very short term and would not be expected to adversely impact the surrounding population or wildlife. WSMR occupies a large area of about 1.5 million ha (3.8 million ac) of relatively undeveloped land. When coupled with the ongoing noise generated by routine types of activities such as military aircraft operations and missile tests at WSMR, the additional cumulative effects of Launch Abort System rocket test noise at WSMR would be minimal. The Launch Abort System tests would also generate exhaust products, principally HCl and Al_2O_3, which would deposit downrange. The cumulative effects of these deposits when considered along with previous and anticipated future launches would be minimal (WSTF 2007b).

At other NASA Centers, implementation of the Proposed Action would not involve major new construction or new types of activities with the potential for substantial environmental impacts. The proposed activities are similar in nature and magnitude to past and ongoing activities in support of the Apollo Program and the Space Shuttle Program. Therefore, the projected cumulative environmental impacts of implementing of the Proposed Action are principally the secondary impacts associated with the workforce that would support the Proposed Action at each respective facility. This includes the support infrastructure, including structures, utilities, and roads, and the impacts of their use, such as waste, impacts to water, noise, and air emissions, as well as the socioeconomic impacts of the workforce on the surrounding communities and region.

At ATK's Promontory facility, the full-scale five-segment solid rocket motor tests planned to support the Constellation Program would produce occasional short-term noise and exhaust products, principally Al_2O_3 and HCl. These test activities would produce impacts similar in character to past, ongoing, and anticipated future solid rocket motor tests at this remote site. Near-term development tests of the Ares I and Ares V solid rocket motors, and long-term test firings of production motors at ATK would release exhaust products to the immediate environment near the test stand and the local environment around the ATK test site. These releases would increase Al_2O_3 and HCl soil concentrations in the immediate vicinity of each test stand. It is expected that future testing activities would be similar in frequency and impacts as past activities. In addition to the Constellation Program actions, ATK also supports other clients who would use the facilities for test firing of rocket motors, resulting in the release of exhaust products in the vicinity of the test stands. The cumulative impact of Constellation Program testing in addition to other past, ongoing, and future solid rocket motor firings would be expected to be minimal.

The principal projected cumulative environmental impacts of implementing of the Proposed Action, coupled with the past, ongoing, and other anticipated activities at ATK, are the accumulation of exhaust deposits in the vicinity of the test stands. The secondary impacts associated with the workforce that would support production of the Constellation Program, including procurement of components, would be comparable to that for the on-going Space Shuttle Program. This includes the support infrastructure, including structures, utilities, and roads, and the impacts of their use, such as waste, water, noise, and air emissions, as well as the socioeconomic impacts of the workforce on the surrounding communities and region.

4.3.2 Cumulative Global Impacts

Implementation of NASA's Constellation Program would result in very small impacts on global warming and stratospheric ozone due to continued energy use and rocket launches.

4.3.2.1 Global Warming

Cumulative global impact from energy use under the Constellation Program when added to past, ongoing, and anticipated future U.S. actions would be expected to be similar to the historical energy use under the Space Shuttle Program. It is NASA's policy to fully comply with the requirements of the National Energy Conservation Policy Act, Executive Order (EO) 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, and other statutory and Presidential directives regarding energy efficiency. NASA strives to reduce energy consumption and cost whenever possible in all facility operations. Each NASA Center and Component Facility has an established energy efficiency program directed at reducing facility energy intensity and associated greenhouse gas emissions as well as expanding the use of renewable energy for facilities and operational activities. See Section 4.1.6.2 for an expanded discussion of NASA energy use.

The total global warming potential from NASA activities is approximately 2.5×10^5 mt (2.8×10^5 tons) carbon-equivalent annually from energy consumption and, over the 2009 to 2020 timeframe for the Constellation Program no more than 1,200 mt (1,300 tons) of CO_2 from rocket exhaust as well as 11,000 mt (12,000 tons) of CO equivalent from rocket exhaust and rocket testing. These are collectively less than 0.004 percent of the projected annual U.S. carbon emissions over that period. Therefore, the Proposed Action (combined with NASA's other energy consumption) would add a negligible amount to the U.S. emissions contribution to global warming.

4.3.2.2 Stratospheric Ozone Depletion

Based on the proposed Constellation Program's 12-year vehicle engine and flight test schedule presented in Table 2-11 (*i.e.*, from 2009 to 2020), implementation of the Proposed Action would potentially result in the deposition of no more than 2,200 mt (2,400 tons) of HCl and 3,000 mt (3,400 tons) of Al_2O_3 in the stratosphere.

For the 2000 to 2010 timeframe, the FAA has estimated that about 1,136 worldwide launches would occur. The FAA estimated that approximately 16,209 mt (17,867 tons) of HCl and 29,329 mt (32,329 tons) of Al_2O_3 would be deposited in the troposphere, and an equal amount deposited in the stratosphere (FAA 2001). If worldwide launch rates and emissions remain at these levels for the 2009 to 2020 timeframe, about 13 and 10 percent, respectively, of the total HCl and Al_2O_3 that would be deposited in the stratosphere would be from Ares launches during that period. This is similar to the amounts that were attributed to the Space Shuttle Program in the *Final Programmatic Environmental Impact Statement for Licensing Launches* (FAA 2001).

Many studies have been conducted on the cumulative environmental effects of launches worldwide. The American Institute for Aeronautics and Astronautics convened a workshop (AIAA 1991) to identify and quantify the key environmental issues that relate to the effects on the atmosphere from launches. The conclusion of the workshop, based on evaluation of scientific studies performed in the U.S., Europe, and Russia, was that the effects of launch vehicle propulsion exhaust emissions on stratospheric ozone depletion, acid rain, toxicity, air quality, and global warming were extremely small compared to other human activities (AIAA 1991, FAA 2001).

4.4 ENVIRONMENTAL IMPACTS THAT CANNOT BE AVOIDED

During engine ground testing, liftoff, and ascent, the rocket engines that would be developed for the Constellation Program would produce short-term noise that cannot be avoided. Short-term noise also occurs during liquid engine testing at MSFC, SSC, and perhaps other facilities and solid rocket motor testing at ATK's Promontory facility. Noise would also occur during test flights at WSMR and KSC and liftoff and ascent of Ares I and Ares V launch vehicles at KSC. At each of the sites, past and ongoing rocket engine tests and launches in support of the Space Shuttle and other programs produce similar noise impacts.

Sonic booms over the Atlantic Ocean under the flight path of the Ares I and Ares V launch vehicles, as well as sonic booms during atmospheric entry of the Orion spacecraft over the Pacific Ocean and the western U.S., cannot be avoided. Initial evaluations indicate that the magnitude of these sonic booms are similar to but lower in magnitude than those associated with launch and atmospheric entry of the Space Shuttle. In addition, there would be jettisoned components during launch vehicle ascent and from the returning Orion spacecraft. The potential environmental impacts associated with these components cannot be avoided.

During solid rocket motor ground testing, launches to test the Launch Abort System at WSMR, Ares test flights at KSC, and Ares I and Ares V launches at KSC, solid propellant exhaust is produced, consisting principally of HCl and Al_2O_3. These exhaust products and their deposition cannot be avoided. The Launch Abort System test launches at WSMR would collectively emit 65 mt (72 tons) of total suspended particulates, 27 mt (30 tons) of PM_{10}, 5.8 mt (6.4 tons) of NO_x, and 44 mt (49 tons) of HCl. Each test firing of five-segment solid rocket motors at ATK's Promontory facility would emit approximately 190 mt (210 tons) of Al_2O_3, 150 mt (170 tons) of CO, 22 mt (25 tons) of CO_2, and 130 mt (150 tons) of HCl. Biota in the immediate vicinity of the test stands could be damaged or killed by the intense heat and HCl deposition from the exhaust cloud. No long-term adverse effects to biota would be anticipated. Al_2O_3 particulates from the solid propellant combustion also would be deposited on soils at the test site as the exhaust cloud travels downwind.

At liftoff and during ascent from KSC, the Ares I First Stage and Ares V SRBs would each emit approximately 190 mt (210 tons) of Al_2O_3, 150 mt (170 tons) of CO, 22 mt (25 tons) of CO_2, 130 mt (150 tons) of HCl, 60 mt (66 tons) of water vapor, 57 mt (63 tons) of nitrogen, 13 mt (14 tons) of hydrogen, and 6 mt (7 tons) of other materials each. In addition, the main engine of the Ares V Core Stage and the Upper Stages of both the Ares I and Ares V vehicles would produce primarily water vapor and water. The exhaust cloud would be concentrated near the launch pad during the first moments of launch. Thereafter, the exhaust cloud would be transported downwind and upward, eventually dissipating to background concentrations. Biota in the immediate vicinity of the launch pads could be damaged or killed by the intense heat and HCl deposition from the exhaust cloud. No long-term adverse effects to biota would be anticipated. Al_2O_3 particulates from the ignition of solid fuel also would be deposited on soils and nearby surface waters at the launch site as the exhaust cloud travels downwind.

Although NASA is committed to reducing the use of ozone depleting substances to the extent practicable, the Constellation Program may still use some of these substances, but would utilize them only in limited, tightly controlled quantities.

4.5 INCOMPLETE OR UNAVAILABLE INFORMATION

This Final PEIS has been developed during the early design stages of the Constellation Program. It is reasonable to expect that there would be changes to the Constellation Program's plans and designs if the Proposed Action is selected. These changes could result from modification to the launch vehicles and the Orion spacecraft, changes to the locations where various research, development, and testing occurs, and their timing, or a reduction in the number of launches from the planned baseline.

These are not anticipated to substantively affect the environmental evaluations presented in this Final PEIS. However, should substantial change occur in the potential environmental impacts, NASA would evaluate the need for additional environmental analyses and documentation.

Several key aspects of the Constellation Program are not sufficiently defined to be thoroughly evaluated in this Final PEIS. These include:

- Potential building modifications or new construction at MAF, if MAF is chosen as the facility for Ares V Core Stage and/or Earth Departure Stage development
- Configuration of a potential new launch vehicle Vertical Integration Facility at KSC
- A new Launch Complex and new Launch Pad at KSC
- A new Crawlerway from the Vertical Assembly Building to LC-39 and new Crawler-Transport at KSC
- Addition of a new building at KSC to process hazardous materials for the Constellation Program
- Extent to which qualified commercial suppliers would be utilized to provide crew and cargo service to and from the International Space Station
- Potential building modifications at ARC in support of Orion Thermal Protection System tests
- Potential Orion Thermal Protection System flight tests
- Need for and magnitude of continued use of ozone depleting substances now used by the Space Shuttle Program, such as HCFC 141b foam
- Candidate Orion terrestrial landing sites
- Development of Lunar Landers, Lunar Surface Systems, Mar Systems, and other future systems to be implemented beyond 2020.

Detailed analysis of the socioeconomic impacts of implementing the Constellation Program cannot be performed at this time as most of the prime contract procurements are not completed.

Furthermore, complete and accurate socioeconomic information, including budgetary data, workforce projections, and future procurement actions in addition to the prime contract procurements are not available thus limiting the ability to quantify the socioeconomic impact of the Constellation Program.

4.6 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE HUMAN ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

4.6.1 Short-Term Uses

Under the Proposed Action, the Ares I and Ares V launch vehicles would be launched from the existing Space Shuttle launch pads at KSC. The short-term affected environment would include the launch complex and surrounding areas. Other nearby activities include commercial, NASA and USAF operations at CCAFS, urban communities, a fish and wildlife refuge, citrus groves, residential communities, and recreational areas. Launch activities for the proposed Constellation Program would be conducted in accordance with past and ongoing NASA and USAF procedures for operations at KSC, CCAFS, the Eastern Range, and in accordance with NASA and U.S. Army procedures at WSMR. Should a launch accident occur under the Proposed Action, short-term uses of HCl-contaminated areas could be curtailed, pending survey and possible mitigation.

Should a ground accident occur, affected environments that could possibly be impacted in the short-term include the immediate vicinity of the test stands at SSC, MSFC, and ATK. Uses of these assets could be curtailed pending survey and possible mitigation.

The proposed Constellation Program would overlap and then continue beyond the close-out of the Space Shuttle Program. At some NASA Centers, many common-use assets would be expected to transition from the Space Shuttle Program to Constellation Program support. No major conflicts between the short-term uses of the facilities have been identified.

4.6.2 Long-Term Productivity

No change to land use at any of the facilities proposed for use by the Constellation Program is anticipated. The region would continue to support human habitation and activities, wildlife habitats, citrus groves, grazing and agricultural land, and cultural, historic, and archaeological areas. No long-term effects on these uses are anticipated.

The pursuit of the proposed Constellation Program would benefit the U.S. Space industry, which is important to the economic stability of the country. In addition to the localized economic benefits at each NASA Center and commercial sites, implementing this program has broader socioeconomic benefits. These include technology spin-offs to industry and other space missions, maintaining the unique capability of the U.S. to conduct space missions, and supporting the continued technical development of scientists and engineers. Furthermore, comprehensive formal and informal education programs would be conducted as public outreach efforts, and proactive small business plans would be implemented to provide opportunities for small, small disadvantaged, and woman-owned small businesses, and historically black colleges and universities.

4.7 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

An irretrievable resource commitment results when a spent resource cannot be replaced within a reasonable period of time. For the Proposed Action, quantities of various resources, including energy, fuels, and other materials, would be irreversibly and irretrievably committed. The use of these resources would be associated with development, vehicle fabrication, launch, and operation of Constellation Program missions.

Fabrication of the launch vehicles and the Orion spacecraft would use electrical and fossil-fuel energy. This constitutes an irretrievable commitment of resources, but would not impose any significant effect on fuel availability. Ground testing, launches, and operation of the Orion spacecraft would consume solid and liquid propellant and related fluids. The solid propellant ingredients for the SRBs would consist of polybutadiene, acrylic acid, and acrylonitrile terpolymer (PBAN). The liquid propellants would include LH and LOX. Typical quantities that would be used are summarized in Chapter 2.

The total quantities of other materials used in the Constellation Program activities that would be irreversibly and irretrievable committed are relatively minor. Typically, these materials include steel, aluminum, titanium, iron, plastic, glass, graphite, nickel, chromium, lead, zinc, and copper. Less common materials used in small quantities may include silver, mercury, gold, rhodium, gallium, germanium, hafnium, niobium, platinum, tantalum, and beryllium.

4.8 ENVIRONMENTAL COMPLIANCE

NASA has completed implementation of an Environmental Management System (EMS) at all of its Centers and Component Facilities determined to be “appropriate facilities” based on the facility size, activities, and potential environmental risks. An EMS is a system that (1) incorporates people, procedures, and work practices in a formal structure to ensure that the important environmental impacts of an organization are identified and addressed, (2) promotes continual improvement by periodically evaluating environmental performance, (3) involves all members of the organization as appropriate, and (4) actively involves senior management in support of the environmental management program. The purpose of the NASA EMS is to have a single overall approach to managing environmental activities that allows for efficient, prioritized program execution.

The NASA Centers that would support the Constellation Program are subject to a vast array of Federal, state, and local environmental statutes, regulations, and orders. Each Center has a staff dedicated to complying with these requirements. In addition, NASA has various internal procedural requirements that pertain to environmental management. This section presents an overview of the principal environmental permitting requirements that apply to the various NASA Centers, with identification and brief discussion of additional environmental licenses and permits (if any) that will need to be obtained specifically for implementation of Constellation Program activities.

Since the activities anticipated under the Constellation Program are similar in nature to the activities conducted currently at the various NASA facilities, it is expected that there be minimal, if any, effects on the current environmental permitting status at each facility. All Constellation

Program activities will be conducted in full compliance with all applicable Federal, state, and local regulations, as well as NASA's internal implementing regulations and procedures. Potential impacts of Constellation Program activities on the environmental compliance status at each affected facility are discussed below by environmental media area.

Other government facilities (*e.g.*, the U.S. Army's WSMR site) and commercial facilities that could potentially support the Constellation Program would also be subject to Federal, state, and local environmental statutes, regulations, and orders. These would include but not be limited to the following areas: air, water, floodplains, wetlands, hazardous wastes, hazardous materials, threatened and endangered species, and safety and health.

<u>Air Resources</u>

The Clean Air Act of 1970 and subsequent amendments (42 United States Code [U.S.C.] 7401 *et seq.)* address ambient levels of air pollution and control programs/requirements for sources of air pollution. Air operating permits are required for facilities that emit regulated criteria and hazardous air pollutants from stationary sources. Stationary sources of air pollutants at NASA facilities include combustion sources (*e.g.*, boilers, generators), engine testing, parts cleaning and degreasing, surface coating, abrasive blasting, wood working, fuel storage and dispensing. Permits are not required for mobile sources of air pollutants, including automobiles and trucks, aircraft, and launch vehicles during liftoff and ascent. However, many launch support activities (*e.g.*, vehicle preparation, assembly, propellant loading) are considered stationary sources.

All of the NASA and contractor facilities associated with the Constellation Program and discussed in this Final PEIS have state air operating permits. Regulated air emissions at several of these facilities exceed the "major source" emission thresholds and, therefore, subject these facilities to the CAA's Title V permitting program (40 CFR Part 70). The following facilities have Title V air operating permits: KSC, SSC, JSC, MSFC, GRC Lewis Field, WSMR, and ATK's Promontory facility. In addition, three facilities (MAF, LaRC, and ARC) have accepted certain emission limitations and operate under "synthetic minor" permits. PBS and ATK's CRC facility are minor sources and operate under general state air operating permits.

The various activities that are proposed to occur at each of these NASA facilities under the Constellation Program are consistent with the current activities conducted at these sites under their existing air permits. It is not expected that any Constellation Program activities will change the regulatory permitting status (*i.e.*, major vs. minor) of any facility. Construction permits and operating permit modifications may be required for the addition of stationary sources associated with any new construction and/or modifications to existing buildings/operations (*e.g.*, at SSC or MSFC). As noted previously, launch emissions and other mobile source emissions are not subject to CAA permitting requirements. The possibility exists that some new sources or "major" modifications to existing sources may exceed the permitting thresholds of the EPA's New Source Review (NSR) or Prevention of Significant Deterioration programs. If that is the case, NASA will conduct the necessary analyses and prepare the appropriate permit application(s). In addition, it is expected that facility-specific NEPA documentation would address any air quality and other environmental impacts associated with such larger sources/modifications.

Three NASA Centers (JSC, GRC Lewis Field, and ARC) are located in areas that are not in attainment (*i.e.*, nonattainment areas) for one or more of the NAAQS. JSC is located in an ozone nonattainment area; Lewis Field is in a nonattainment area for $PM_{2.5}$ and ozone (which is also a maintenance area for PM_{10}, CO, and SO_2); and ARC is located in a nonattainment area for ozone, PM_{10}, and $PM_{2.5}$ (which is also a maintenance area for CO). Therefore, activities conducted at these Centers must be consistent with the corresponding State Implementation Plan (SIP) and new actions (*i.e.*, Federal actions) must comply with EPA's General Conformity regulations (40 CFR Parts 51 and 93) established under Section 176(c) of the CAA.

<u>Water Resources</u>

The Clean Water Act of 1977, as amended (33 U.S.C. 1251 *et seq*.), provides regulatory guidelines for water quality and governs the discharge of pollutants into surface waters. The NASA facilities that would support Constellation Program currently generate a variety of sanitary, storm, and industrial wastewaters that must be managed in accordance with the CWA and the implementing EPA and state regulations.

The management of sanitary and industrial wastewaters and stormwaters varies by facility, with some NASA facilities having their own wastewater treatment facilities and others relying on local municipalities, or a combination thereof. In all cases, the treatment and discharge of these wastewaters is permitted by the applicable state and/or local regulatory agencies. Any wastewater is discharged in accordance with the National Pollutant Discharge Elimination System (NPDES) permitting program requirements and a permit issued by either EPA or the state. It is expected that the Constellation Program activities will generate wastewaters of similar composition at volumes within levels currently permitted for at each NASA facility. Therefore, Constellation Program activities will not require substantial modifications to existing permits and no adverse impacts are expected to surface water resources.

<u>Floodplains and Wetlands</u>

Executive Order 11988, *Floodplain Management*, and Executive Order 11990, *Protection of Wetlands*, as amended 42 U.S.C. 2473(c)(1), mandate that Federal agencies take actions to minimize their impacts on floodplains and wetlands. NASA has promulgated its own regulations for floodplain and wetlands management (14 CFR 1216.2) that require, among others, that each field installation prepare a base floodplain map, incorporate floodplain management and wetlands protection into land use planning activities, and consult with applicable agencies (*e.g.*, the U.S. Army Corps of Engineers [USACE], Federal Emergency Management Agency [FEMA], and USFWS) when proposing to construct a facility in a floodplain/wetland.

Many of the NASA facilities that would be utilized under the Constellation Program have areas that have been identified as floodplains and/or wetlands. However, most of Constellation Program activities are expected, in large part, to utilize existing facilities and, therefore, would have minimal, if any, impacts on floodplains and wetlands. In addition, most new construction activities would likely occur in previously developed areas of the facilities, further minimizing impacts on such resources. NASA will consult with the appropriate Federal and state agencies, as required, if necessary. The construction of the Test Stand A-3 at SSC impacts wetlands. SSC has performed wetlands banking with USACE to mitigate this impact.

Hazardous Material Management

Hazardous materials are regulated under a number of Federal statutes, including the Toxic Substances Control Act (TSCA) of 1986, as amended (15 U.S.C. 2601 *et seq*.); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended (42 U.S.C. 9601 *et seq*.), the Emergency Planning and Community Right-to-Know Act (EPCRA), as amended (42 U.S.C. 11001 *et seq*.), and the Hazardous Material Transportation Act (HMTA) of 1970, as amended (49 U.S.C. 1803 *et seq*.).

Any hazardous materials needed by the Constellation Program would be procured and managed by the NASA facilities and their contractors in accordance with all applicable Federal, state, and local requirements. The types of hazardous materials that would be used by the Constellation Programs are expected to be similar in nature to those currently used by the Space Shuttle Program and other NASA activities.

Hazardous Waste Management

The Resource Conservation and Recovery Act (RCRA), as amended (42 U.S.C. 6901 *et seq*.), corresponding state law, and associated Federal and state regulations establish regulatory requirements for managing hazardous wastes. Hazardous wastes must be collected, labeled appropriately, and stored in hazardous waste collection areas prior to treatment and/or disposal.

All of the principal NASA facilities associated with the Constellation Program are currently classified as “large quantity generators” of hazardous waste as they generate 1,000 kg (2,200 lb) or more of hazardous waste or more than 1 kg (2.2 lb) of acute hazardous waste per calendar month. In addition, six installations (KSC, MAF, JSC, WSMR, and ATK’s Promontory and CRC facilities) have RCRA permits for treatment, storage, or disposal facilities. Any hazardous wastes generated by the Constellation Program would be managed in accordance with all applicable Federal, state, and local requirements and existing permits. The types and quantities of hazardous wastes that would be generated by the Constellation Program are expected to be similar in nature to those currently generated by the Space Shuttle Program and other NASA activities. It is anticipated that the Constellation Program would not result in substantial changes to the current regulatory status of any facility.

Pollution Prevention

The Pollution Prevention Act of 1990, as amended (42 U.S.C. 13101 *et seq*.) and Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, provide the regulatory framework for Federal installations to implement source reduction, waste minimization, recycling, and reuse programs. NASA Policy Directive NPD 8500.1A, *NASA Environmental Management*, established NASA’s policy to prevent or reduce pollution at the source whenever possible. NASA also participates in a partnership with the military services called the Joint Group on Pollution Prevention to reduce or eliminate hazardous material or processes.

All NASA facilities have individual pollution prevention plans, and various pollution prevention initiatives to identify and implement cost-effective waste reduction opportunities. The development and implementation of the Constellation Program is consistent with these initiatives.

Biological Resources

Federal mandates for the conservation and protection of biological resources include, but are not limited to, the Endangered Species Act (ESA), as amended (16 U.S.C. 1531 *et seq*.), the Marine Mammal Protection Act of 1972, as amended (16 U.S.C. 1361 *et seq*.), and the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703 *et seq*.). NASA has consulted with the NMFS regarding potential impacts to essential fish habitats at KSC from Ares launches. Established standard practices (*e.g.*, complying with the light management plan stipulated in a USFWS/NASA Memorandum of Agreement for nesting sea turtles and hatchlings at KSC) would be observed to minimize impacts to these resources.

Coastal Zone Management

The regulatory framework for coastal zone management is provided by the Federal Coastal Zone Management Act of 1972, as amended (16 U.S.C. 1451 *et seq*.), which establishes a national policy to preserve, protect, develop, restore, and enhance the resources of the nation's coastal zone. KSC would follow the State of Florida's requirements. No added impacts beyond those normally associated with the Space Shuttle launches would be anticipated. MAF also is located in a coastal zone and has a Coastal Management Plan Permit to cover barge activities. NASA will consult with the appropriate authorities if barge activity necessitates the need to modify the existing permit. LaRC and SSC also would follow all coastal zone management regulations, as appropriate.

Cultural Resources

The National Historic Preservation Act (NHPA), as amended (16 U.S.C. 470 *et seq*.), addresses the protection of historic properties and establishes the National Register of Historic Places (NRHP). NHPA Section 106 outlines the requirements for Federal agencies to consider the effects of an action on properties listed on, or eligible for, the NRHP. The Advisory Council on Historic Preservation (ACHP) Section 106 regulations (36 CFR Section 800), *Protection of Historic and Cultural Properties*, provides the procedures for Federal agencies to meet their obligations under the NHPA, including inventorying resources and consultation with State Historic Preservation Offices (SHPOs) and federally-recognized Native Americans. Other related Federal statutes include the Native American Graves Protection and Repatriation Act, the American Indian Religious Freedom Act, and the Archaeological Resources Protection Act, among others.

All of the principal NASA facilities associated with the Constellation Program have one or more historic properties that are either listed on the NRHP or are eligible for NRHP listing. NASA will consult with the appropriate SHPO and with ACHP for concurrence on adverse effect determination and mitigation measures proposed. Approved mitigation plans will be documented in MOAs before major modifications are made to historic resources, as appropriate. NASA will consult with appropriate Native American groups if any Constellation Program activity has the potential to impact archaeological resources or Traditional Cultural Places.

Worker and Public Safety and Health

The Federal Occupational Safety and Health Act of 1970, as amended (29 U.S.C. 661 *et seq*.), authorized the development and enforcement of standards to ensure safe and healthful working conditions. States have promulgated similar statutes and regulations. These regulations are followed on a daily basis by NASA and would be followed in the future under the Constellation Program to ensure the protection of worker and public safety and health from all aspects of the Program, including, among others, excessive noise from rocket engine testing and launches, and exposure to hazardous materials and hazardous wastes.

Additional Permits at NASA Facilities

Each of the NASA facilities which support the Space Shuttle Program and commercial contractors such as ATK have Federal, state, and local permits necessary to support the Space Shuttle Program and would, therefore, be expected to perform most of the activities that would be anticipated to support the Constellation Program with current or extended permits.

At this early stage of the Constellation Program, only a few situations have been identified where either new environmental permits or substantial modifications to existing permits would be required to support the Constellation Program. It is reasonable to expect, however, that if the Proposed Action is selected, additional permits might be needed.

NASA has had an agency-wide effort to eliminate ODS from use, with an exception for mission-critical space applications. Mission-critical uses remain for the Space Shuttle Program (*e.g.*, for use of TCA) and would be transferred to the Constellation Program after the Space Shuttle fleet is retired. NASA is currently in the process of evaluating alternative substances for the materials.

Specific additional permits that might be needed or substantially modified with implementation of the Proposed Action are listed in Table 4-30.

International Agreements

International agreements relating to the use of the global commons are considered in assessing ocean environmental impacts. A broad array of international environmental agreements has been developed over the last century, with most being coordinated in the past few decades under the auspices of the United Nations.

The U.S. is party to the London Dumping Convention of 1972 which is intended to prevent pollution of the oceans by waste dumping or other activities that could cause hazards to humans, living resources and marine life or damage amenities or interfere with other legitimate uses of the ocean. It is commonly agreed that discharges of launch vehicle stages or residual fuel in the jettisoned stages are not covered by the London Dumping Convention or by the 1996 Protocol to that Convention, as they do not fall within the meaning of "dumping" as defined by Article III (FAA 1999).

Table 4-30. Additional Permits Possibly Required to Support the Proposed Action

Facility	Type of Permit Possibly Required for the Proposed Action
KSC	May require an additional permit or an amendment to the existing Florida Department of Environmental Protection NPDES permit to discharge water used for noise suppression and wash-down water during an Ares V launch. May require "take" permits from the USFWS for sea turtles.
SSC	May require a CAA Title V, PSD permit to discharge air pollutants from the A-3 Test Stand. NPDES permit will require an update to include sound suppression system water and steam condensate discharge from the A-3 Test Stand. Obtained a MDEQ Large Construction Storm Water Permit and a U.S. Army Corps of Engineers wetlands disturbance authorization for A-3 Test Stand construction activities. Also obtained a Department of Marine Resources waiver for constructing a bulkhead and mooring dolphins. Preparing to apply for MDEQ 401 Water Quality Certification and U.S. Army Corps of Engineers 404 Permit for work to be done in the SSC Access Canal.
MAF	None Identified
JSC	None Identified
MSFC	May require a CAA Title V permit to discharge air pollutants from the Main Propulsion Test Article engine testing and to operate the spray-on foam booth for the Ares I Upper Stage.
GRC	None Identified
LaRC	None Identified
ARC	None Identified
DRFC/GSFC/JPL	None Identified
WSTF/WSMR	None Identified
ATK – Promontory and CRC	None Identified

In addition, the U.S. is a signatory, though not a party to, the United Nations Convention on the Law of the Sea (UNCLOS). UNCLOS has a comprehensive framework governing the use of the ocean and protecting the marine environment. Article 87 expressly provides for freedom of the high seas. Articles 116 through 120 concern living resources on the high seas and Part XII of UNCLOS pertains to protection and preservation of the marine environment. Article 194(1) of UNCLOS requires nations "to prevent, reduce and control pollution of the marine environment…using the best practicable means at their disposal and in accordance with their capabilities…" Article 194(2) requires nations "to take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other States and their environments…"

The U.S. is a party to the International Convention for the Prevention of Pollution from Ships (MARPOL) of 1973. MARPOL guidelines are incorporated into ship practices relevant to recovery vessels.

Planetary Protection

The Constellation Program would be required to follow NASA's planetary protection policy. This policy is aimed at protecting Solar Systems bodies from contamination by Earth life and protecting Earth from possible life forms that may be returned from other Solar System bodies.